SCIENCE ABSTRACTS.

Section A.—PHYSICS.

APRIL, 1930.

GENERAL PHYSICS.

1267. Robust Microbalance of High Sensitivity. J. W. McBain and H. G. Tanner. *Roy. Soc., Proc.* 125. *pp.* 579–586, *Nov.* 1, 1929.

A robust and compact microbalance, capable of use under very varied conditions, sensitive to 4×10^{-9} gm. and capable of weighing at least 0·3 gm. is described. The two crystal points of carborundum on which the balance rests are superior to a knife edge in sharpness, hardness and chemical inertness. Preliminary experiments on the adsorption of toluene vapour gave results several times higher than that corresponding to a monomolecular film for a true plane surface, but this was offset by the irregular surface of the platinum actually employed. A conception is put forward which would explain higher values of adsorption without reference to the classical assumption of a thick compressed film and providing an alternative to the hypothesis of multimolecular layers built up by superposition of monomolecular layers. Authors.

1268. Registration of Pendulum Oscillations without Material Connections. F. Hope-Jones. *Roy. Astron. Soc., M.N.* 90. *pp.* 154–156, *Nov.*, 1929.

In a note concerning this problem [see Abstract 856 (1930)] Ferrié states the case against clicks, ratchet wheels and their contacts, and also that the problem has not been solved. It was solved, however, by British clockmakers years ago, and a diagram is reproduced from the *British Horological Journal* of January, 1906, representing a mechanism in which the moment of contact corresponds with the identical instant of the period of the pendulum, and there is no interference with the latter.

M. A. E.

1269. New Method for Determining Size of Particles by Means of X-Rays. R. Brill and H. Pelzer. *Zeits. f. techn. Physik*, 10. 12. *pp.* 663–666, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

When Debye-Scherrer preparations are employed in the form of hollow cylinders interference bands are obtained with two maxima, and the distance between these is a function of the size of the component crystallites. This distance can be determined accurately by photometric measurement of the photographic record, and much better results can be obtained than by measurement of the half-value breadth of the interference bands, as in the ordinary method. Describes an X-ray camera designed for taking the necessary exposures. H. N. A.

1270. Mercury Meniscus. K. C. D. Hickman. *J.O.S.A. and R.S.I.* 19. *pp.* 190–212, *Oct.*, 1929. *Comm. No.* 398 *from the Kodak Research Lab.*

Five degrees of purity of mercury are defined, the third—freedom from grease and from base metals (by distillation)—corresponding to most laboratory experiments. A corresponding series of lubricants for mercury-glass interfaces is derived from a study of (i) the motion of Hg globules on a tilted glass plate, (ii) the behaviour of the Hg meniscus in glass tubes. It is shown that dust and other impurities (*e.g.*, oxides) form a rigid skin between the mercury and the glass, hampering the free motion of the column and distorting the meniscus on its recession. A good lubricant should give good boundary (unimolecular) lubrication, should possess polar groups so that it is strongly adsorbed either to the mercury or to the glass and is not completely squeezed out on standing, and should dissolve the surface film; for lubrication *in vacuo* it should possess a low vapour pressure. Butyl phthalate and butyl benzyl phthalate (vapour pressures *c.* 10^{-6} mm. at 25° C.) used at the rate of 2 drops per cm^2., are ideal for high vacuum work; phenyl hydrazine may be added (2 %) for long duration work at moderately low pressures, or thio-acetanilide (1 %) for short duration experiments. For experiments at atmospheric pressure an acidified 1 % solution of $HgNO_3$ (protected from evaporation) is very efficient. With these lubricants the meniscus should give a true reading without tapping and no line of contact should be visible between the mercury and the glass. L. V. C.

1271. Surface Tension of Solutions. Mutual Influences of Urethane and Salt upon their Solubility and Solution Volumes in Water. S. Palitzsch. *Zeits. f. phys. Chem.* 145. *Abt. A.* 2. *pp.* 97–108, *Nov.*, 1929.

The data of the previous investigations [see Abstract 1401 (1929)] are recalculated and examined with respect to possible relations between solubility and solution volume on the one hand and surface tension on the other. The salts are chlorides, sulphates, etc., of the alkalis and other metals; some 400 solutions of 26 salts are studied at 25° C. The solution volumes of urethane itself increase almost in proportion to its concentration; the presence of salts has very little or no influence, and there is no relation between surface tension and solution volume. As regards solubility, 473 gm. of urethane are soluble in 100 gm. of water. The presence of a few per cent. of urethane makes the water saturated as to both NaCl and KCl and to urethane, whilst a little urethane makes the water a better solvent for LiCl. The same salt may increase or decrease the salt solubility, according as the concentration is referred to the weight of water or to the volume of the solution; this is a density influence. There is no distinct relation between solubility and surface tension. H. B.

1272. Viscosity of Barium Chloride Solutions. G. Jones and M. Dole. *Am. Chem. Soc., J.* 51. *pp.* 2950–2964, *Oct.*, 1929.

Measurements have been made on the viscosity of solutions of barium chloride at 25° covering the range 0·005 to 1·0 molal. The fluidity (reciprocal of the viscosity) of these solutions can be computed within the limit of error of the data from the equation $\phi = 1 - 0{\cdot}02013\sqrt{c} - 0{\cdot}20087c$. It is shown that an equation of the form $\phi = 1 + A\sqrt{c} + Bc$ can be made to fit the data by proper choice of the values of A and B in the case of many other salts for which precise data are available extending to low concentrations. The value of A is negative for all strong electrolytes for which accurate data are available. This term probably represents the stiffening effect on the solution of the electric forces between the ions which tend to maintain a space lattice structure. The value of A is zero for non-electrolytes. The value of B may be either positive or negative. Most salts resemble barium chloride in causing an increase in viscosity or a decrease in fluidity at all concentrations giving a negative value to B. In such cases the equation is apparently valid up to about 1 molal. Some salts cause an increase in the fluidity or a decrease in the viscosity over a wide range of concentration, so that the value of B in the equation is positive. In such cases the equation is apparently valid up to nearly 0·2 molal. AUTHORS.

1273. Internal Friction of Electrolytic Solutions and its Interpretation According to Debye's Theory. H. Falkenhagen and M. Dole. *Phys. Zeits.* 30. *pp.* 611–622, *Oct.* 1, 1929.

Jones and Dole [see preceding Abstract] have shown recently that the relative internal friction $\eta_\mu : \eta_0$ of very dilute solutions increases as the square root of the concentration, or $\eta_\mu = \eta_0(1 + A\sqrt{\mu})$, where n_μ is the coefficient of viscosity at the concentration μ equivalents per litre and η_0 the coefficient for $\mu = 0$. In the present paper the simplest case of binary electrolytes with ions of equal mobility is considered theoretically in accordance with Debye's theory, it being shown that the above relationship is a consequence of the interionic Coulomb forces. The general case of simple electrolytes is to be considered later. T. H. P.

1274. Viscosity of Vapours. Parts I and II. A. G. Nasini. *Phil. Mag.* 8. *pp.* 596–604, *Nov.*, 1929.

Part I considers the influence of molecular association on the viscosity of acetic acid. The coefficient of internal friction of the vapour of acetic acid has been examined through a range of temperature from 90° to 250° C., the experiments having been made under reduced pressures and the values from 150° to 250° taken to be those of the simple acetic acid molecule. The temperature-viscosity curve shows at lower temperatures an opposite shape to those of non-associated compounds. The deviations from Sutherland's law are examined from different points of view, and critically discussed. Part II discusses the relationships between critical constants and gaseous viscosity; tables of data being included. H. H. Ho.

1275. Friction Constant and Wall-Surface Film. J. Traube and S. H. Whang. *Zeits. f. phys. Chem.* 145. 3–4. *pp.* 257–264, 1929.

In reply to Tausz and Körösy [see Abstract 1399 (1929)] and Erk [see Abstract 1750 (1929)] the authors admit that they were wrong in the interpretation of their experiments [see Abstract 662 (1929)], because they did not consider the influence of surface tension on the velocity of efflux. Experiments with small sealed glass tubes, sufficiently weighted to rise only very slowly when released under water, showed that greasing the glass outside with polar oils did not accelerate the rate of rising by buoyancy. There is thus no proof that the Helmholtz sliding coefficient can be greater than zero. They still maintain, however, that for substances like alcohols, esters and ketones, which are soluble in water, wholly or partly in molecular dispersion, there is in general parallelism between the surface tensions at the boundary aqueous solutions/oleic acid and aqueous solution/paraffin and the surface tensions at the boundary aqueous solution/air. This does not apply to colloidal solutions [see Abstract 470 (1928)]. As regards the permeability of membranes, it is further suggested that the theories of Collander, Ruhland and Michaelis cannot be maintained, and that the addition of surface-active substances facilitates, and sometimes renders possible, the passing of water through the membrane. H. B.

1276. Motion of a Sphere in a Viscous Fluid. T. J. I'A. Bromwich. *Cambridge Phil. Soc., Proc.* 25. *pp.* 369–383, *Oct.*, 1929.

The Stokes formula throws no light on the way in which the velocity of a sphere in a viscous fluid approaches its steady value, and, in seeking an alternative solution, the most effective method of attack has been found to depend on the operational methods introduced originally by Heaviside. Since the most interesting part of the problem is to decide how the sphere approaches the steady state, a solution has been obtained in the form of two asymptotic series. Numerical applications of the formulæ are given. H. H. Ho.

1277. Measurement of Flow and Viscosity of Fluids by Means of Resistance Bodies. G. Ruppel and K. J. Umpfenbach. *Zeits. f. techn. Physik,* 10. 12. *pp.* 647–651, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

Experiments were made with small-scale laboratory apparatus, and on a large technical scale. The principle adopted was to suspend a horizontal disc or a sphere in a stream of fluid passing upward through a pipe having the form of an inverted cone; a light rod passed through the centre of gravity of this resistance body, to which it was fixed; the upper end of this rod passed into a glass tube provided with graduations, so that the position of the resistance body in the conical tube could be measured, while the lower end carried a scale pan in which weights could be placed to balance the force due to fluid friction. Gives curves showing how the resistance number, *Beiwert,* varies continuously with the Reynolds number from the turbulent into the region of laminar flow for different ratios of d, the diameter of the resistance body, to a, the diameter of the pipe at the position of the resistance body. The resistance, *Beiwert,* curve begins to rise when the Reynolds number falls to about 400 for all values of d/a. H. N. A.

1278. Stationary Movement in Viscous Fluids. B. Finzi. *Accad. Lincei, Atti,* 10. *pp.* 334–335, *Oct.*, 1929.

Stationary movement is impossible in a viscous fluid adhering completely to the contour of a surface within a finite space, in presence of external conservative forces. The same if the surface be at an infinite distance. A. D.

1279. Hydrodynamics. E. Raimondi. *Accad. Lincei, Atti,* 10. *pp.* 344–348, *Oct., and pp.* 420–423, *Nov.* 3, 1929.

Works out the problem of the dynamical effect of a translatory current surrounding a thin cylinder in the neighbourhood of a plane of indefinite extent. The dynamical effect of the current on the rigid part is found to be nil. A. D.

1280. Hydrodynamics. U. Cisotti. *Accad. Lincei, Atti,* 10. *pp.* 469–475, *Nov.* 17, 1929.

Investigates the types of rigid isolated profiles which undergo a dynamical action under a local fluid current flowing within them. A. D.

1281. Stability of Motion of a Viscous Fluid between Two Rotating Cylinders. H. Faxén. *Arkiv f. Mat. Astron. och Fysik, Stockholm,* 21A. 26. [11 *pp*], 1929.

The convergence of series occurring in Taylor's analysis is established, and the correctness of the final formulæ confirmed. [See Abstract 1129 (1928).] J. S. G. T.

1282. Rotating Discs in a Fluid. E. G. Barrillon. *Comptes Rendus,* 189. *pp.* 734–736, *Nov.* 4, 1929.

Theoretical and experimental work on this subject is discussed, and conclusions are drawn as follows: For values of x immediately below and above $2{\cdot}3 \times 10^5$, where $x = \log \omega a^2/\nu$ (a being the radius of the disc and ν the coefficient of viscosity), a unique formula can represent the rotation, and the transition from one state to the other is progressive. Also, that the theory of the rotating disc as deduced from the limiting case of a sphere having concentric layers is not valid even for very low speeds of rotation. H. H. Ho.

1283. Most General Cases of Integrability of Equations of Motion of a Solid Body in a Liquid. Kourensky. *Comptes Rendus,* 189. *pp.* 838–840, *Nov.* 18, 1929.

For Olsson's integral, $y_3 = 0$, it is necessary to have only three conditions. The problem of integration of the equations of motion, for the cases of Olsson and that of the author, reduces to quadratures. J. J. S.

1284. Oscillatory Motion of a Viscous Liquid in an Open Channel of Infinite Length. S. Higuchi. *Phys. Math. Soc., Japan, Proc.* 2. *pp.* 139–142, *Nov.*, 1929. *In English.*

The open channel is assumed to be of semi-circular section and the motion is treated under the assumptions: (1) that $\partial p/\partial z = 0$, $u = v = 0$; and (2) that there are no external forces along the axis z except that due to the oscillatory motion of the wall of the channel, where p is the pressure and u, v and w represent the velocity components of x, y and z. The results may have some relation to the motion of river water or ditch water caused by an earthquake. The paper is entirely mathematical. H. H. Ho.

1285. Velocity Distribution in Water Circulating Uniformly about a Central Axis. K. Kimura and S. Hasimoto. *Faculty of Sci., Tokyo, J.* 1. *pp.* 439–463, *Nov.* 25, 1929. *In English.*

Two methods are used: water is caused to circulate (i) in a tank, 3 × 2 × 1 m., half filled, by means of a vertical plate of brass, 3 × 3 cm., fixed on a vertical axis near the bottom and rotated from below; and (ii) in a cylindrical vessel, dia. 54·3 or 111·7 cm., with a circular hole in the bottom, dia. 0·7 or 1·9 cm., rotation being started by hand and then continuing by itself. Surface motion is indicated by small pieces of paper floating on the surface, which is kinematographed; internal motion by jets of a solution of potassium permanganate from capillary tubes placed at various positions, or by grains of permanganate allowed to sink from the surface. Numerous diagrams and photographs are given. The various motions and ultimate turbulence are discussed in detail, the chief conclusion being that horizontal circulating velocity at a distance r from the centre of the vortex is expressed by k/r^n, where k is a quantity dependent on the vortex strength, and varying with the time, and n a positive fraction asymptotically approaching unity with time. C. A. S.

1286. Stability or Regularity of Motion in a Viscous Liquid. J. Pérès. *Comptes Rendus,* 189. *pp.* 898–900, *Nov.* 25, 1929.

Derives certain results regarding the movement of an eddy in a viscous liquid by means of integrals analogous to that employed by W. Ekman in his article on the change from steady to turbulent motion of liquids. Only plane problems are dealt with. H. N. A.

1287. Aerodynamic Attraction between Rotating Cylinder and Neighbouring Plane. E. Raimondi. *Accad. Lincei, Atti,* 10. *pp.* 169–172, *Aug.,* 1929.

If a narrow rectangular plate, or a long cylinder, be set in rapid rotation near a plane of considerable area with respect to the dimensions of the rotating element, and if the whole system be in air, there is a force of attraction set up between the moving element and the plane. This force increases with the speed of rotation, and decreases as the distance of the plane from the rotating system is increased. A similar phenomenon is exhibited when a smaller solid cylinder rotates within a larger hollow cylinder, the two cylinders being non-axial. Some experimentally determined values of the force of attraction are given. J. W. T. W.

1288. Oseen's Hydrodynamical Equations and the Problem of the Slipstream from an Ideal Propeller. J. M. Burgers. *K. Akad. Amsterdam, Proc.* 32. 9. *pp.* 1278–1290, 1929. *In English.*

Oseen's hydrodynamical equations relate to the disturbances, caused by the presence of a body or by the action of external forces, in a stream of fluid moving originally with constant velocity. The author discusses the case when forces of constant intensity f per unit area act at points on a disc of radius a defined by $x_1 = 0$, $x_2^2 + x_3^2 \leq a^2$, the axis $0x_1$ being parallel to the direction of the general flow. More especially the author discusses the question as to whether the surface of discontinuity given by the solution of Oseen's equations for zero value of the viscosity coincides with the boundary of the slipstream. It appears that for large values of Reynolds number the motion is such as is to be anticipated on general grounds. The intensity per unit length of the vortex layer is inversely proportional to its mean velocity; the pressure is continuous and the distribution of vorticity over the thickness of the layer is such that the " centre of gravity " of an element of the layer falls in the boundary of the slipstream. J. S. G. T.

1289. Differential Equation in Two-Dimensional Motion of a Compressible Fluid and the Associated Variational Problems. H. Bateman. *Roy. Soc., Proc.* 125. *pp.* 598–618, *Nov.* 1, 1929.

Taylor and Sharman recently [see Abstract 382 (1929)] have discussed the flow of a compressible fluid by an experimental method, and have formulated tentatively the criterion that no irrotational solution of the equations of motion exists when the velocity of the fluid at any point of the field of flow exceeds the local velocity of sound, although they do not claim any theoretical ground for the general truth of the hypothesis. The present author points out that there is a change in type of the governing partial differential equation when the local velocity of sound is exceeded, and he discusses the case of steady motion in two dimensions. Supplementary conditions of elliptic type are then considered, together with an associated variational problem. The remaining subjects dealt with are: variational principles giving the equations of vortex motion;

hyperbolic equations with elliptic boundary conditions; elliptic region completely surrounded by a hyperbolic region; a non-linear equation which changes in type; hyperbolic region only and when completely surrounded by an elliptic region. H. H. Ho.

1290. Turbulent Wake Behind a Body of Revolution. L. M. Swain. *Roy. Soc., Proc.* 105. *pp.* 647–659, *Nov.* 1, 1929.

Prandtl has shown that, assuming that for large Reynolds numbers the motions in sections perpendicular to the direction of flow are mechanically and geometrically similar, the " mixing path " (Mischungsweg) l in the wake behind a solid body is approximately proportional to the breadth of the wake. It is then possible to express l in such a form that the only undetermined factor is an absolute constant. Prandtl has obtained a first approximation for a cylindrical solid body (a two-dimensional case) and for a solid of revolution; the results obtained experimentally for the cylinder showed a slight deviation from the theoretical ones. The object of the present paper is to find whether a second approximation to the motion in the case of a solid of revolution will give a result nearer to the experimental one than the first approximation, and this is shown to be so. H. N. A.

1291. Effect of Pressure on Electrical Resistance of Manganin as a Method of Measuring Pressure. A. Michels and M. H. Lenssen. *K. Akad. Amsterdam, Proc.* 32. 10. *pp.* 1379–1385, 1929.

The treatment required by this material in order to ensure its constancy was first investigated. The actual resistance of the wire under pressure was not measured, but a differential method was used, in which the ratio of the resistances of the wire under pressure and of a similar wire at the same temperature but not under pressure was determined. The apparatus employed is described, and the method of procedure given. The values of the ratio at the various pressures obtained at 20° C. and at the highest temperatures after different heat treatments are given in a table and the corresponding pressure coefficients for the different ranges of pressure in a following table. After heat treatment the variation of the resistance of manganin with pressure for lower temperatures was sufficiently reproducible to make it possible to use this effect to measure pressure. T. C. H.

1292. Development of Experimental Methods in Photoelasticity. Z. Tuzi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 209. *pp.* 21–36, *Oct.* 20, 1929. *In English.*

The author describes an investigation of stress distribution by means of his new photographic method, for which he claims greatly improved accuracy over the older method. The chief material used was phenolite. [See also next Abstract.] H. H. Ho.

1293. Photoelastic Study of Stress Distributions in the Side-Framing of a Steel Car. Z. Tuzi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 210. *pp.* 37–68, *Oct.* 20, 1929. *In English.*

The stress distribution has been studied experimentally by means of the author's photographic and kinematographic method. The phenolite specimens employed were prepared in a close imitation of an actual side-framing having several rectangular openings corresponding to the entrances of passengers and windows, etc. The experimental and theoretical results are compared and discussed. [See also preceding Abstract.] H. H. Ho.

1294. Cubical Dilatation. G. Supino. *Accad. Lincei, Atti,* 10. *pp.* 414–419, *Nov.* 2, 1929.

If a system of forces in equilibrium act upon a single plane zone of the surface of an elastic solid, the total cubical dilatation produced in the solid by these forces is nil. A. D.

1295. Experimental Study of the Deformation of a Chronometer Hair Spring. G. P. Arcay. *Comptes Rendus,* 189. *pp.* 900–902, *Nov.* 25, 1929.

The spring investigated previously was provided with theoretical terminal curves. The investigation has now been extended to the case of a spring without curves. The statical and kinematic deformations were determined photographically in the positions of greatest extension, greatest contraction, and when the velocity of the balance wheel was a maximum. In each case the positive corresponding to the static position was superposed on the negative obtained in the same position during the oscillation of the balance wheel. Not the least difference could be observed between the two images. The author concludes that it is legitimate to use the statical method in testing such springs. H. N. A.

1296. Energy of Elastic Bodies with Infinite Changes of Shape. C. W. Oseen. *Arkiv f. Mat., Astron., och. Fysik, Stockholm,* 2A. 17. [8 *pp.*] 1929. *In German.*

The author summarises the results obtained by Manville, Almansi and Kötter in their mathematical expressions for this quantity, and gives reasons for errors which arise in using these expressions. He next sets out the conditions which such an expression for an isotropic body has to satisfy and develops the equations. R. S. R.

1297. Motion of a Body of Variable Mass. E. Fermi. *Accad. Lincei, Atti,* 9. *pp.* 984–986, *June* 1, 1929.

A continuation of former papers [see Levi-Civita, Abstract 2068 (1929)]. Discusses mathematically the effect of the fall of meteorites upon planets. E. E. F. d'A.

1298. Problem in Oscillations. P. Dore. *Accad. Lincei, Atti,* 10. *pp.* 62–68, *July,* 1929.

The influence of the elasticity of the support upon the periods of oscillation of two pendulums simultaneously oscillating upon it, considered. Applications to geophysics. A. D.

1299. Phenomena of Interference of Curves of Vibration. J. W. N. le Heux. *K. Akad. Amsterdam, Proc.* 32. 10. *pp.* 1386–1397, 1929.

The composition of four vibratory movements directed in two rectangular senses is shown in a series of formulæ, and enables the author to give the means of drawing out a system of curves of vibration with the help of rule and compass, and proceeding from this the idea of constructing an apparatus which will trace very rapidly and in particular very exactly complicated figures. A diagram show an example of the construction of a system. The method employed is very fully explained. The graphic tracing of curves of vibration by means of an apparatus consisting of four pendulums grouped in the form of an orthogonal cross is next described. The cases of two inversed circular movements, two linear and rectangular movements and two unequal elliptical movements are all

carefully examined, and many illustrated examples given. The paper concludes with a summary of deductions drawn from the data obtained.
T. C. H

1300. External Ballistics. C. Burali-Forti. *Accad. Sci. Torino, Atti*, 64. 7A–8A. *pp.* 146–158, 1928–1929.

The absolute motion is studied of a projectile reduced to a barocentre and mass, by geometrical methods differing from the usual, which put the resistent function in a new light. The solution may be extended to projectiles having the form of convenient solids of rotation. A. D.

1301. Nearly Periodic Motions. A. Markoff, Jr. *Comptes Rendus*, 189. *pp.* 732–734, *Nov.* 4, 1929.

The author simplifies a theorem by Franklin upon motions which are nearly periodic, *viz.*, that for such a stable motion it is necessary and sufficient that it be recurring and possess the property S, which latter is defined as follows: a motion $x(t)$ at each $\epsilon > 0$ has associated with it a quantity $h(\epsilon) > 0$, such that $\rho\{x(t_1), x(t_2)\} < h(\epsilon)$ and involving that $\rho\{x(t_1 + t), x(t_2 + t)\} < \epsilon$ whatever t_1, t_2 and t may be. The simplified theorem is that for a stable and almost periodic motion it is only necessary and sufficient that it possess the property S. H. H. Ho.

1302. Theory of Mixtures as a Probability Problem. K. Lichtenecker. *Phys. Zeits.* 30. *pp.* 805–809, *Nov.* 15, 1929.

The problem considered is that of calculating the properties of a mixture from a knowledge of its composition, together with the corresponding properties of the components. Different classes of mixtures are recognised, according as the process defined by the property considered depends on elementary electron processes or not. If u is a parameter varying from 0 to 1 according to the problem considered, x_1 and x_2 the properties of the components, and n_1 and n_2 their concentrations, the equation put forward for the property x in the mixture is

$$x = (n_1x_1 + n_2x_2)^u \, (n_1/x_1 + n_2/x_2)^{u-1}.$$

When $u = 0$ or 1, this reduces to the laws familiar in the cases of electrical resistances in series or in parallel. If $u = \frac{1}{2}$, it is numerically similar to the logarithmic law. A note added on proof-correction points out that the law ought to be of such a form that the properties of a mixture predicted directly by the law, ought to agree with those predicted by it if the mixture is considered not as a mixture of the pure substances, but of two mixtures of the original materials. The law put forward does not fulfil this condition. J. H. A.

1303. Symmetry of the Continuum. A. Schubnikow. *Zeits. f. Krist.* 72. 3. *pp.* 272–300, *Nov.*, 1929.

Gives an account of the infinite manifold of one, two and three dimensional continuous groups, and explains it by means of examples drawn from crystallography and from other physical phenomena in which symmetry plays a part. Gives the symbols adopted for an infinitely long prism with n sides, for an electric current flowing through such a prism, or through a cylinder, for different forms of screw, for a homogeneous electrical field, the field of polarised light, an infinitely large monoaxial crystal which rotates the plane of polarisation of light passing through it, and other optical cases. Fluid crystals are regarded as statistically homogeneous materials, containing very small particles which are nearly equal to one another, have the symmetry of a certain point group, and are arranged parallel to one another with nearly equal density. They have the symmetry of the continuous groups and not that of the mesh and chain groups which Alexander and Hermann have ascribed to them.

H. N. A.

1304. Crystal Structure of Ammonium Copper Double Chloride $(NH_4)_2CuCl_4 . 2H_2O$. L. Chrobak. *Acad. Polonaise Sci. et Lettres, Bull.* 7A. *pp.* 361–389, *July*, 1929. *In German.*

Crystals of the double salt $(NH_4)_2CuCl_4 . 2H_2O$ are obtained by evaporation at room-temperature of saturated aqueous solutions of cupric chloride, $CuCl_2 . 2H_2O$ and ammonium chloride, in the proportions 1 : 1 and 1 : 2. In both cases the crystals have an apparently rhombododecahedral habit, and show optical anomalies, which are partly accounted for by internal stresses. Laue X-ray photographs, etch figures and percussion figures show that the crystals have a tetragonal holohedral structure. Rotating crystal X-ray analysis indicate that this substance belongs to a simple tetragonal translation group Γ_t with the values $a = 7 \cdot 58$ Å. and $c = 7 \cdot 95$ Å., the elementary cell containing two molecules $(NH_4)_2CuCl_4 . 2H_2O$. This is considered as built up on an ionic basis, the positions of the two Cu^{++}, four $(NH_4)^+$, eight Cl^- ions and four H_2O being located. The space group is D_{4h}^{14}.

A. J. M.

1305. Technical Treatment of Easily Deformed Crystals for X-Ray Work. L. Chrobak. *Acad. Polonaise Sci. et Lettres, Bull.* 8A. *pp.* 498–505, *Oct.*, 1929. *In German.*

Describes how many soft, splintery or brittle crystals can be prepared, so as to produce undeformed preparations for the Laue and the rotating crystal methods, by the use of threads moistened with a suitable solvent as saws for cutting the required sections, and of strips of filter paper moistened with the solvent as lathe cutting tools, for obtaining a cylindrical preparation when this is required; a surface may be ground by rubbing on a piece of ground glass, on which a small quantity of the solvent is placed. Some instrumental details for X-ray work are also described.

H. N. A.

1306. Systematic Structural Theory. H. Heesch. *Zeits. f. Krist.* 72. 2. *pp.* 177–201, *Oct.*, 1929.

The space groups are classified from a simple and comprehensive point of view. German capital letters are employed for the group symbols, with suffixes and indices which indicate the 21 symmetry elements of the Schoenflies–Niggli terminology. Symbols are given for all the 230 space groups, and the sub-groups are also dealt with. [See also Abstract 38 (1930).]

H. N. A.

1307. Chemical and X-Ray Investigations on Materials and Crystals of Complex Structure. B. Gossner and M. Arm. *Zeits. f. Krist.* 72. 2. *pp.* 202–236, *Oct.*, 1929.

Deals with a number of complicated minerals and artificial crystals, including

$(SO_4)_6K_5H_7 . 3FeO_3H_3.H_2O$;
$(SO_4)_6K_2H_{10} . 3(FeAl)O_3H_3 . 4SO_4Fe . 4H_2O$;
$(SO_4)_6K_2H_{10} . 3FeO_3H_3 . 4SO_4Mn . 4H_2O$;

the same with Co substituted for Mn; $3 PbCl_2 . 3CuO_2H_2 . AgCl$ and cumengeit which may be 4 $PbCl_2 . 4CuO_2H_2 . H_2O$. The value of zM, where M is the molecular weight and z the number of molecules in the elementary cell, was determined by X-ray methods and, since z in most cases was nearly a whole number, the above formulæ for the different crystals were confirmed. The elementary cell was often large, and contained a number of the above molecules, *e.g.*, 8, 9 or 20. The crystal form was often simple, in some cases cubic, and some of the complicated substances showed very small optical anomalies, while less complicated ones showed large anomalies. The paper concludes with some theoretical considerations or pseudo-symmetrical crystals. H. N. A.

1308. Structure of Crystalline Hydrates. A. Kapustinsky. *Zeits. f. phys. Chem.* 144. *Abt. A.* 3–4. *pp.* 187–196, *Oct.*, 1929.

The thermal capacity of crystalline hydrates of salts with kations of low charge density (up to about 25 coulombs per Å.^{2} . 10^{-21}—that is, with K, Na, Rb, Li, Cs, Ca and Ba) may be calculated on the basis of Kopp's law. In many cases, however, the influence of the anion, which as yet cannot be calculated, introduces complications. With salts the kations of which have charge densities higher than the above value (Cu, Zn, Mg, La, Fe, Ni), the thermal capacity may be calculated by the formula $C = c + 6 \cdot 64 + 9 \cdot 2(n - 1)$, where C and c are the respective molar thermal capacities of the crystalline hydrate and the anhydrous salt, 6·64 is the mean thermal capacity of the first water molecule, 9·2 that of ice for the (mean) temperature of the experiment, and n the number of molecules of water in the crystalline hydrate. From a comparison of the thermal effects and the charge densities, it appears that in crystalline hydrates of salts of Zn, Mg, Mn, Cu, La, Fe and Ni, the first molecule of water of crystallisation is combined constitutionally, the hydroxyl group being united to the metal and the hydrogen with the anion. This conception, which is in agreement with Werner's theory, and also with the electrostatic theory of chemical affinity, provides an interpretation of various observed phenomena. From the standpoint of most recent results on the structure of water, a structural image of the crystalline hydrates is developed. T. H. P.

1309. Crystal Structure of Tetramethyl-, Trimethyl- and Triethylmethyl-Ammonium Chlorostannates. R. W. G. Wyckoff and R. B. Corey. *Am. J. Sci.* 18. *pp.* 437–446, *Nov.*, 1929.

In all three cases the atomic arrangement is of the CaF_2 type. The unit cubes contain 4 molecules, and have edge lengths of 12·87 Å., 12·19 Å. and 13·51 Å. in $[N(CH_3)_4]_2SnCl_6$, $[NH(CH_3)_3]_2SnCl_6$ and $[NCH_3(C_2H_5)_3]_2SnCl_6$ respectively. The tetramethyl body is apparently holohedral with an atomic arrangement which, like $(NH_4)_2SnCl_6$, is based upon Oi–5(O_h^5). The parameters defining the chlorine and carbon atoms are probably not far from u(chlorine) = 0·19, and u'(carbon) = 0·31. The trimethyl-ammonium chlorostannate is pyritohedral with a symmetry described by the space group Ti–6(T_h^6). In this crystal the $SnCl_6$ groups are rotated somewhat about threefold axes from the symmetrical positions which they occupy in the holohedral tetramethyl compound. The symmetry of the triethylmethyl compound is apparently tetartohedral, but the diffraction data make it probable that the $SnCl_6$ groups have substantially the more symmetrical orientation shown by $(NH_4)_2SnCl_6$ and $[N(CH_3)_4]_2SnCl_6$. A. J. M.

1310. X-Ray Diffracting Power of Chlorine and Ammonium in Ammonium Chloride. R. W. G. Wyckoff and Alice H. Armstrong. *Zeits. f. Krist.* 72. 4. *pp.* 319–326, *Nov.*, 1929. *In English.*

X-ray scattering (structure-factor or F-) curves have been determined for ammonium chloride by measuring the relative intensities of the first 19 lines by the powder method. Monochromatic radiation (K–α doublet of molybdenum) was used and powder fine enough to pass through a 125-mesh per linear cm. sieve pressed into a cake thick enough to give maximum reflection. Values of F were calculated as for an ideally imperfect crystal, arbitrary values of intensities experimentally determined being reduced to absolute values of F on the basis of F(220) for sodium chloride being 15·62 ($\lambda = 0{\cdot}71$ Å.) [see James and Firth, Abstract 823 (1928)]. Atomic F-values for chlorine closely agreed with those deduced from sodium chloride. A Fourier analysis of the data indicates humps in the right relative positions, those for ammonium being smaller and broader. C. A. S.

1311. Crystal Structure of Potassium Perrhenate. E. Broch. *Zeits. f. phys. Chem.* 6. *Abt. B.* 1. *pp.* 22–26, *Nov.*, 1929.

The lattice of potassium perrhenate is body-centred tetragonal, and belongs to the space group c_{4h}^{6}. The lattice dimensions are $a = 5{\cdot}615$ Å.; $c = 12{\cdot}50$ Å.; $c/a = 2{\cdot}226$. From the X-ray data it is calculated that the compound has the density $d = 4{\cdot}887$. F. J. W.

1312. Crystal Structure of Wurtzite. M. L. Fuller. *Phil. Mag.* 8. *pp.* 658–664, *Nov.*, 1929.

A method of preparing wurtzite quite free from cubic zinc sulphide by heating cubic zinc sulphide with 10 % of sodium chloride at 1100° C. is described. The observed intensities on powder patterns are in good agreement with those calculated for space group 6*e*–4 with $V = \frac{5}{8}$. The unit-cell dimensions of wurtzite are found to be: $a_0 = 3{\cdot}811 \pm 0{\cdot}004$ Å., $c_0 = 6{\cdot}234 \pm 0{\cdot}006$ Å. and $c/a = 1{\cdot}636$. AUTHOR.

1313. Mosaic Crystals. F. Zwicky. *Nat. Acad. Sci., Proc.* 15. *pp.* 816–822, *Nov.*, 1929.

Outline of a new theory to account for the "structure sensitive" properties of crystals. The lattice determined by X-ray analysis, although dynamically stable, is thermodynamically unstable. Thermodynamical stability imposes on this primary structure a further secondary structure, which is also perfectly regular and has to be interpreted, in general, as a slight periodic variation in density. The secondary structure gives rise to the "structure sensitive" properties. The formation of cracks [see Abstract 2671 (1929)] is believed to be due to this secondary structure. The theory readily accounts for the hysteresis properties of single crystals and the production of slipping in crystals. Various optical effects predicted theoretically on this theory have been tested experimentally, and have been found to be in good agreement with the facts. G. C. McV.

1314. X-Ray Investigation of Statistical Anisotropy in Crystalline Mosaics. W. E. Schmid. *Zeits. f. Physik*, 56. 11–12. *pp.* 740–750, 1929.

When X-rays are diffracted by a mosaic of crystallites (such as a textile fibre) the diffraction ring is complete and the orientation of the crystallites is perfectly random. If, however, there are crystalline planes bearing a definite orientation, spots will result on the circumference of what would be the complete ring, provided that the setting of the apparatus is such that the reflection circle can cut the net plane. The paper describes a method of analysis of the figures obtained as above, using a wooden sphere on which curves are traced, and a transparent celluloid cap to fit over the sphere, on which spots are marked. A. C. M.

1315. Asymmetry of Corrosion Figures Produced by an Isotropic Active Liquid. L. Royer. *Comptes Rendus*, 189. *pp.* 932–933, *Nov.* 25, 1929.

Calamine (rhombic hemimorphic), when etched with an inactive organic acid, gives on (010) and $(0\bar{1}0)$ figures with no centre of symmetry, but symmetrical relatively to (100), and for which the zone axis (001) is a binary axis of symmetry. The same faces, etched by an active acid, while otherwise similar, show no symmetry relative to (100), the crystal thus displaying a tetartohedral form. Crystals of *d*- and *l*-tartaric acid etched by various active alcohols show that a *d*-crystal etched by a *d*-liquid gives figures enantiomorphous with those formed by an *l*-liquid on an *l*-crystal, but are quite different from those formed by a *d*-liquid on an *l*-crystal, or by an *l*-liquid on a *d*-crystal, these two again being enantiomorphous *inter se*. [See also Abstract 3238 (1929).] C. A. S.

1316. Lattice Structure of Certain Simple Sugars. J. Hengstenberg and H. Mark. *Zeits. f. Krist.* 72. 3. *pp.* 301–308, *Nov.*, 1929.

For *d*-glucose the dimensions of the unit cell (4 mols.) are $a = 10\cdot40$, $b = 14\cdot89$, $c = 4\cdot99$ Å., density 1·544, space group V^4. For *d*-cellobiose, $a = 5\cdot00$, $b = 13\cdot2$, $c = 11\cdot1$ Å., density 1·556, space group C_2^2, 2 mols. in unit cell. For *d*-fructose, $a = 8\cdot06$, $b = 10\cdot06$, $c = 9\cdot12$ Å., density 1·598, space group V^4, 4 mol. in unit cell. T. H. P.

1317. New Kind of Mixed Crystals of the Type $BaSO_4$ and $KMnO_4$. V. Chlopin and B. Nikitin. *Zeits. f. phys. Chem.* 145. *Abt. A.* 2. *pp.* 137–151, *Nov.*, 1929.

The method of radioactive indicators was employed to test some of Grimm's mixed crystals [see Abstract 1483 (1928)]. In the formation of these crystals the existence of a lower limit of miscibility is demonstrated which serves to distinguish them from true mixed crystals. The structure of the crystals is discussed, and it is considered that they may be regarded as a stage in the transition from a true mixed crystal to a layered crystal. [See also Abstract 2670 (1929).] G. E. A.

1318. Crystal Structure of the Mixed Crystal Series CuI—AgI. G. Lunde and P. Rosbaud. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 115–117, *Nov.*, 1929.

The observation of Barth and Lunde that CuI and AgI at ordinary temperature form a loose, porous, mixed crystal series resembling the zinc blende type is confirmed for preparations made according to Reichel by crystallisation from solutions. J. K.

1319. Crystal Orientation Determinations. B. Schmidt. *Zeits. f. Physik*, 58. 9–10. *pp.* 577–584, 1929.

An extension of Schiebold and Sach's method for determining the orientation of crystals with increased accuracy is described. Laue photographs are taken and stereographic projections made. The method can be applied to crystals of any symmetry, including monoclinic and triclinic, if the directions of the axes are otherwise known. Examples are given. W. H. Ge.

1320. Disposition of Oxygen Atoms in Arsenic Oxides. U. Dehlinger. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 127–134, *Nov.*, 1929.

A study of the positions of the oxygen atoms in arsenic tetroxide. The X-ray determinations are compared with the transformation curve, and the colour changes in passing from Sb_2O_5 to Sb_2O_3. W. H. Ge.

1321. Interaction of Excited Helium and Hydrogen Atoms. H. Jones. *Cambridge Phil. Soc., Proc.* 25. *pp.* 445–453, *Oct.*, 1929.

Uses the methods of Heitler and London, who have shown that the first order perturbation energies of two atoms, taken as a function of the separation between the nuclei, give a fairly good description of the behaviour of the atoms with regard to possible molecular association, have made detailed calculations for hydrogen, and have considered the case where each atom contains many electrons in less detail. Examines in detail the interaction of a hydrogen atom in its normal state and a helium atom either in the 2^3S or 2^1S state. As the result of his calculations the author is able to find the energy for different distances between the nuclei; with the He atom in the 2^3S state and with the electron spins of the two atoms so related that elastic reflection takes place, no minimum appears in the energy curve; with the He atom in the 2^3S state, the spins being so related that there is a minimum, this minimum corresponds to an equilibrium separation of 1·75 Å., the moment of inertia being $4 \cdot 05 \times 10^{-40}$ gm. cm.^{2} and the dissociation energy 0·74 volt. A curve is also obtained with the He atom in state 2^1S, which has no minimum and indicates elastic reflection between the hydrogen and helium atoms. H. N. A.

1322. Pendulum Orbit of Normal Hydrogen Molecule. D. Buchanan. *Roy. Soc. Canada, Trans.* 23. *Sect.* 3. *pp.* 125–131, *Jan.*, 1929.

The normal hydrogen molecule, H_2, consists of two nuclei with equal positive charges of electricity and two electrons negatively charged. In the pendulum model the electrons oscillate back and forth along a straight line, which is the right bisector of the join of the nuclei. It is also assumed that the electrons move so as to be always equidistant from the join of the nuclei. The problem considered in this paper is the determination of periodic solution for the electrons, the principles of classical mechanics only being used. It is assumed that the nuclei are so massive, compared with the electrons, that they are not disturbed from their positions by the attraction of the electrons. The case of the H_2^+ ion, where one of the electrons is lacking, is also considered. It is immaterial whether the nuclei are stationary or rotate in circles about their centre of gravity. H. H. Ho.

1323. Effective Cross-Section of Inert Gas Molecules towards Electrons below 1 Volt. C. Ramsauer and R. Kollath. *Ann. d. Physik*, 3. 4. *pp.* 536–564, *Nov.*, 1929. *Phys. Zeits.* 30. *pp.* 760–766, *Nov.*, 1929.

The previous experimental method [see Abstracts 584 and 1054 (1929)] has proved suitable for this investigation from which the following results were obtained: helium below 1 volt gives an almost horizontal curve with slight crests and troughs; neon falls continuously to 0·15 volt; argon, krypton and xenon again rise after the lowest velocities; the voltage of the minima, as also the gradient of the fall and rise corresponding serially to A, Kr, Xe. The main results of the quantitative measurements for He, Ne and Xe were confirmed by a qualitative method, *viz.*, by form and change of the magnetic velocity-distribution curve on transition from vacuum to gas. A comparison is made between the present and previous data. H. H. Ho.

1324. Effective Cross-Section Curves of Hydrocarbon Chains. E. Brüche. *Phys. Zeits.* 30. *pp.* 815–817; *Disc.*, 817, *Nov.* 15, 1929. *Paper read before the Deut. Physikertag, Prague, Sept.*, 1929. *Ann. d. Physik*, 4. 3. *pp.* 387–408, *Feb.*, 1930.

For different velocities of electrons detached from saturated hydrocarbons, characteristic curves are obtained, and such curves are now drawn for methane, ethane, propane, butane and pentane. The measurements were carried out with a magnetic Ramsauer apparatus. The relationships between form of curve and molecular structure are discussed. [See also Abstract 505 (1930).] H. H. Ho.

1325. Possible Metallic Form of Nitrogen. G. Horowitz. *Zeits. f. Physik*, 58. 9–10. *pp.* 710–717, 1929.

Shows that, since there is a similarity between the electronic structure of the ion N^+ and the carbon atom, a homopolar attraction between the N^+ ions is possible. Imagines a lattice built up of such ions and of electrons. Calculates the energy relations of the lattice by means of wave mechanics, and comes to the conclusion that the existence of a solid (metallic) form of metastable nitrogen, excited to 3 volts as compared with the normally excited form of the element, is possible. It appears from the calculations that such a solid form of nitrogen would be similar in properties to ordinary organic explosives, and it would explode if one atom were shifted far enough from its position of equilibrium in the lattice.

H. N. A.

1326. Electronic States in Hydride Molecules. E. Hulthén. *Arkiv f. Mat., Astron., och. Fysik, Stockholm*, 21B. 5. [5 *pp*.], 1929. *In English.*

Refers to recent work by Hund and by Mulliken on the assignment of quantum numbers to electrons in molecules, and to that of Franck, Birge and Sponer on the energy limits of vibrational states in molecules. The author has studied the band spectra of the metal hydrides of the second group of the periodic table, and gives a diagram showing the distribution of the electronic levels. In addition to the $^2\Pi \rightarrow {}^2\Sigma$ transitions already known, a set of faint $^2\Sigma' \rightarrow {}^2\Sigma$ transitions were found, emitted by very unstable $^2\Sigma'$ states. A few other band systems appear, but their relations to the author's term table are not yet established. The $^1\Sigma' \rightarrow {}^1\Sigma$ transition found by Bengtsson in the ultra-violet band spectrum of beryllium hydride is also mentioned. The relation between the molecular states in question and the atomic states related to them are considered in detail for HgH and AlH; for the latter new data obtained by Bengtsson are employed, and for both hydrides energy curves have been drawn as functions of the nuclear spacing. H. N. A.

1327. New Form of Quantised Energy in the Mercury Atom. R. G. Loyarte. *Phys. Zeits.* 30. *pp.* 678–687, *Oct.* 15, 1929. *Univ. Nac. la Plata, Estudio Ciencias, No.* 89. *pp.* 7–29, *Dec.*, 1929.

It is shown that the critical potentials of mercury which do not correspond to quantum jumps between optical levels of the arc series can be deduced from the latter by addition or subtraction of a multiple of

1·4 volts. The theory is put forward that the 1·4 volts correspond to a quantum of rotational energy of the mercury atom, and it is shown that this rotation would not influence the theoretical value of the specific heat. The origin of the quantised rotation under the conditions of critical potential experiments is discussed, and the mechanism of energy interchange between the rotating atom and an impinging electron is investigated. W. S. S.

1328. Rotating Electron in a Beam of Light. B. M. Sen. *Phil. Mag.* 8. *pp.* 690–697, *Nov.*, 1929.

A mathematical paper giving the solutions of Dirac's relativity wave-equations for a rotating electron in a beam of plane polarised light. The amplitudes of the vibrations of the light waves are taken to be small and their squares are neglected. The appropriate wave-functions and stream-vector are calculated. G. C. McV.

1329. Stability Relationships of Principal as well as of Subordinate Configurations. A. F. Richter. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 111–114, *Nov.*, 1929.

Based on the stability relationships of the principal configurations and the Nessheim–Samuel modification of the Bohr–Stoner sub-group division, the work of detachment of the first as also of the second stage of ionisation is rendered quantitatively intelligible. Conversely, the scheme referred to is hereby supported. H. H. Ho.

1330. Calculation of Atomic Frequencies in Solids. R. de Mallemann. *Comptes Rendus*, 189. *pp.* 736–738, *Nov.* 4, 1929.

Calculations of atomic frequencies in solids or liquids have been made by Einstein, Lindemann and Debye. According to the latter the frequencies should constitute an acoustic spectrum limited by a maximum frequency, a view criticised by Jeans. The author now shows that the existence of a limiting frequency may be established from simple considerations, *viz.*, in a discontinuous medium, which is the seat of autonomous stationary vibrations, the semi-wave-length may not be less than the shortest equilibrium distance of the particles constituting the medium. H. H. Ho.

1331. Modern Concepts in Physics and their Relation to Chemistry. I. Langmuir. *Science*, 70. *pp.* 385–396, *Oct.* 25, 1929.

Traces the advances in physical theory during the last 35 years or so. The discovery of X-rays by Röntgen in 1905 marked the beginning of an extraordinary revolution in physics. It was only in 1905 that Planck showed how difficulties in the theory of radiation could be solved by assuming a discontinuity in the vibrations of the electrons, thus leading to the quantum theory. Einstein's relativity theory was first stated in 1905. The recent remarkable advances in quantum mechanics have been stimulated by the desire to formulate all concepts in terms of operations. Deals with the use of models, mechanical and mathematical, the gradual growth of the Bohr atomic model and the model of the atom contained in the results obtained by means of wave mechanics or matrix mechanics. Points out the probable future importance of the new methods to the chemist, and shows that there are already indications that these will supply the most fertile source of knowledge of chemical equilibria. Chemistry will then undoubtedly react upon physics, and will provide the physicist with very rich experimental data. H. N. A.

1332. Generalised Form of New Statistics. S. Chandrasekhar. *Phys. Rev.* 34. *pp.* 1204–1211, *Oct.* 15, 1929.

A mathematical investigation of the form of the partition function for an ideal gas leading to equivalent results to those obtained by Strum [see Abstract 886 (1929)] on the assumption that the probabilities of absorption and emission of atoms in a radiation field are respectively equal to $B_a\rho + C_a\rho^2 + \ldots$ and $A + B_e\rho + C_e\rho^2 + \ldots$ instead of $B_a\rho$ and $A + B_e\rho$ (the Einstein equations). The generalisation of the Boltzmann H-theorem is worked out, and the modified Planck radiation formula is given. G. C. McV.

1333. Generalised Two-Dimensional Gibbs Statistics. K. C. Kar and R. Mazumdar. *Zeits. f. Physik*, 55. 7–8. *pp.* 546–554, 1929.

Somewhat different forms of statistical mechanical theory associated with the names of Planck, Bose, Einstein, Fermi, Dirac, Brillouin have been proposed from time to time. These differ in the form of expression employed to express the probability of a state. The authors now propose a statistical theory based upon the Gibbs differential expression for the probability of a canonical distribution, which enables formulæ associated with the Bose-Einstein and Fermi-Dirac theories to be derived. [See also following Abstract.] J. S. G. T.

1334. Generalised Statistics and Schrödinger's Mechanics. K. C. Kar and K. K. Mukherjee. *Zeits. f. Physik*, 59. 1–2. *pp.* 102–109, 1929.

In a previous paper [see preceding Abstract] Kar and Mazumdar have combined classical statistical theory with the Bose-Einstein and Fermi-Dirac theories into a generalised two-dimensional Gibbs statistics. A similar treatment is now extended to the correlation of classical statistics and Schrödinger's wave mechanics. The basis of the mathematical treatment is that the phase-space is slightly compressible so that in six-dimensional phase-space, when a molecule associated with a phase-point is set in motion, it affects statistically the motion of all other molecules. Between each two molecules in statistical equilibrium, therefore, there exists a purely statistical force which is entirely different from the Newtonian force. J. S. G. T.

1335. Quantisation of the Asymmetric Top. H. A. Kramers and G. P. Ittmann. *Zeits. f. Physik*, 58. 3–4. *pp.* 217–231, 1929.

Continuing previous work [see Abstract 2108 (1929)], formulæ are developed which allow of the approximate computation of the energy levels for large values of the impulse quantum number, in the case of the asymmetric top. Mathematical. W. S. S.

1336. Criticism and Explanation of Quantum Theory. E. Gaviola. *Zeits. f. Physik*, 58. 9–10. *pp.* 651–666, 1929.

Most, if not all, physical phenomena can be explained in two different ways (*a*) by the use of wave theories for both radiation and matter, (*b*) by the use of corpuscular theories. The law of causality holds so long as we describe a given phenomenon in terms of one theory only. A breakdown in this law, *e.g.*, an instantaneous quantum jump of an electron from one orbit to another in an atom which is absorbing radiation, can be traced to an attempt to use both theories together in the description of a single physical process. The meaning of Planck's constant h in the energy-frequency relation $E = h\nu$ is that of a proportionality factor between the units appropriate to the theories (*a*), in which ν is used, and (*b*) where E is used. This interpretation of the quantum theory is supported by detailed discussions of emission and absorption phenomena, resonance fluorescence, photoeffect, etc. G. C. McV.

1337. Operators of Quantum Mechanics. P. Franklin. *J. Math. Phys., Mass. Inst. of Technology,* 8. *pp.* 235–245, *Oct.*, 1929.

It is shown that the methods laid down in quantum mechanics, in its various forms, for determining the operator corresponding to any given classical Hamiltonian function, do not lead to a unique correspondence between operators and Hamiltonians, and that the different methods are not in general consistent one with another. W. S. S.

1338. Dirac's Wave Equation and Riemannian Geometry. V. Fock. *J. de Physique et le Radium,* 10. *pp.* 392–405, *Nov.*, 1929.

The theory of the parallel displacement of a " demi-vector " (π-functions of Dirac) leads to four invariant linear wave equations in Riemannian space. These equations are a generalisation of a special case of Dirac's equations for special relativity, characterised by a particular choice of the orthogonal matrices. A non-symmetrical tensor can be formed which corresponds to the energy tensor: its divergence is equal to the mechanical force in the electromagnetic field and it satisfies the equations of motion of relativity theory. A geometrical interpretation of the operator $\left(p_\sigma - \frac{e}{c}\phi_\sigma\right)$, found in Dirac's equations, arises from the theory, and this, it is hoped, will furnish a basis for the unification of the theories of matter and electricity. G. C. McV.

1339. Absolute Motion. B. Rossi and G. Racah. *N. Cimento,* 6. *pp.* 317–319, *Aug.–Sept.–Oct.*, 1929.

By the reaction which a luminous body in motion suffers from the luminous energy emitted, Stark believes [see Abstract 2743 (1929)] that the absolute velocity of the body itself may be defined. The authors analyse his method, and show that one of his hypotheses denies one of the principles of relativity. A. D.

1340. Relativity in Quantistic Mechanics. G. Wataghin. *Accad. Lincei, Atti,* 10. *pp.* 423–429, *Nov.* 3, 1929.

Develops from a single variational principle the principal differential equations used in quantistic mechanics and the theory of relativity. A. D.

1341. Relativity Transformation of an Oscillation into a Travelling Wave, and de Broglie's Postulate in Terms of Velocity Angle. V. Karapetoff. *J.O.S.A. and R.S.I.* 19. *pp.* 253–266, *Nov.*, 1929.

The author's previously given method of representation of space-time relationships in restricted relativity, by means of oblique coordinates, is briefly reviewed [see Abstract 2543 (1926)]. The theory is then applied to the following problems: Two observers, S and S′, are moving at a relative velocity q. The S′ observer has in his system a set of pointers distributed parallel to q, and oscillating in synchronism and in phase with one another. It is required to describe the motion as seen by the observer S. By drawing two sine waves in the Lorentzian plane, it is shown graphically that for the S observer the pointers do not swing in synchronism, but form a travelling wave whose velocity of propagation, u, is connected with q by the familiar relationship $uq = c^2$, where c is the velocity of light. Introducing the so-called velocity angle α, determined by the relationship $\sin \alpha = q/c$, various other properties of the travelling wave, as seen by S, are deduced, such as the apparent frequency at a point in space, the apparent amplitude and its velocity of propagation, the Fitzgerald contraction of the oscillating system, and the slowing down of the frequency of oscillation. By assuming a large number of S′ systems whose velocity angles differ from each other by very small amounts, the group velocity of the " super-light " waves is shown to be equal to the velocity q of the original S′ system. Finally, de Broglie's quantum principle is stated and transformed in terms of the velocity angle α.

AUTHOR.

1342. Foundations of Relativistic Cosmology. H. P. Robertson. *Nat. Acad. Sci., Proc.* 15. *pp.* 822–829, 1929.

The line element of space-time is derived from the single physical assumption that space-time is a manifold spacially homogeneous and isotropic which satisfies Einstein's gravitational equations for an appropriate value of the energy tensor. Coordinates separating space and time having been fixed, it is shown that this assumption is mathematically equivalent to stating that space-time shall admit a certain group of transformations. Hence the line-element is found and the value of the corresponding energy tensor is calculated. The manifold with this line-element can be represented as a hypersurface in a flat space of five dimensions and shows a unique Doppler effect due to distance. It is not, however, a stationary manifold in general. The special case when space-time is stationary is obtained and leads to the universes of Einstein (cylindrical) and de Sitter (spherical) as the only two possibilities. G. C. McV.

1343. Variations of Curvatures in the Deformation of a Curve in Riemannian Space. A. J. McConnell. *Roy. Irish Acad., Proc.* 39. *pp.* 1–9, *Oct.*, 1929.

The author discusses the variations of curvatures and normals at corresponding points of neighbouring curves having a one-to-one correspondence between their points. The treatment employs tensor-analysis throughout. It is shown that of all curves passing through two fixed points, having their first P curvatures given constants, and satisfying certain terminal conditions, those which have their (P + 1)th curvatures zero have stationary lengths. J. S. G. T.

1344. Displacement or Deviation of Circles in Riemannian Space. J. L. Synge. *Roy. Irish Acad., Proc.* 39. *pp.* 10–20, *Oct.*, 1929.

The displacement of circles in a Riemannian space of N dimensions, the line-element being positively definite, is discussed, and the equation of displacement of geodesics is discussed in a manner somewhat simpler than that used in recent papers by Levi-Civita and the author. J. S. G. T.

METEOROLOGY, GEOPHYSICS AND ASTROPHYSICS.

1345. The Tephigram. Theory and Practical Use in Weather Forecasting. C. M. Alvord and R. H. Smith. *Monthly Weather Rev.* 57. *pp.* 361–369, *Sept.*, 1929.

The author explains the construction of the tephigram, a curve connecting the entropy (ϕ) or logarithm of the potential temperature and the absolute temperature (T) and the representation on it of isentropics, isotherms, isobars, dry and saturated adiabatics, density of water vapour and the depegram. The interpretation of the curve to show where rain develops and energy is available is taken. Two main types of tephigrams are discussed which are particularly useful for local forecasting, (1) frontal, showing the approach and passage of the boundary of two different air masses and (2) convective, showing convection in a homogeneous air mass. Examples of the use of each in U.S.A. are given. It is stated that with the help of this diagram thunderstorms can be forecast not less than six hours ahead. R. S. R.

1346. Temperature Indicator for Use with Pilot Balloon. G. Chatterjee. *Gerlands Beitr. z. Geophys.* 24. 4. *pp.* 343–352, 1929. *In English.*

The paper describes a simple instrument intended to be used with ordinary pilot balloons for determining definite temperature-levels in the atmosphere. The instrument is essentially a two-pronged form in which both prongs are bi-metallic strips that open outwards as the temperature falls. At a set temperature, the opening of the prongs releases a chemical "trigger" by allowing a very small capillary U-tube containing strong sulphuric acid to drop into a finely powdered mixture of sugar and potassium chlorate. This burns the string holding the instrument to the balloon. The release of the instrument from the balloon at the predetermined temperature is observed in the field of view of a theodolite and the height of the balloon at the moment is determined by the tail method. The weight of the instrument is about 40 gm. AUTHOR.

1347. Turbulence in Lower Atmospheric Strata. M. Lombardini. *Accad. Lincei, Atti*, 9. *pp.* 898–902, *May* 19, 1929.

Calculates tables of turbulence for various wind velocities and latitudes [see Abstract 2650 (1929)]. E. E. F. d'A.

1348. Influence of Wind on Evaporation from a Plane Surface. N. Szweikowski. *Gerlands Beitr. z. Geophys.* 24. 2–3. *pp.* 293–308, 1929.

The purely empirical formula of Schirbeck, according to which evaporation is proportional to the square root of the wind velocity, is now found to be valid only when the collateral diffusion can be neglected in comparison with the removal of the water vapour by the wind. In this particular case, Schirbeck's law appears to follow as a direct consequence of the application of Cauchy-Briot's method to the solution of the partial differential equation of the evaporation. In the general case, however, the application of this method shows that the absence of collateral propagation is not only sufficient, but also necessary, in order to obtain a relationship of such a nature. The solutions of the partial differential equations obtained have been confirmed by alternative methods (*e.g.*, of Green). H. H. Ho.

1349. Inhibitory Effect of Strong Winds on Rainfall. H. Kusakabe and T. Muto. *Faculty of Sci., Tokyo, J.* 1. *pp.* 465–480, *Nov.* 25, 1929. *In English.*

The apparent connection between the failure of a depression to give rain at a place where, from its distance from the centre of the depression, rain might be expected, and the existence at that place of a strong wind (exceeding 8 m. per sec.), has been investigated by plotting separately the distance and direction of the centres of such depressions from Tokyo when rain began to fall there, on days when there was, and when there was not such a wind, and comparing the results. These support such a connection. Various possible explanations are discussed. C. A. S.

1350. Influence of Smoke and Hot Gases from Factory Chimneys on Rainfall. J. R. Ashworth. *Roy. Meteorolog. Soc., J.* 55. *pp.* 341–350, *Oct.*, 1929.

An examination of the rainfall records at Rochdale, a manufacturing town, for the periods 1918–1927 and 1898–1927, showed (1) a smaller average rainfall total on Sundays than on weekdays, the difference being considerably more than the probable error and (2) the duration was greater during the working hours 7 a.m. to 6 p.m. than for the other part of the day. There was also a close agreement between the amount of impurities and the rainfall. The author considers the hot gases and smoke from factory chimneys increase the rainfall. In the *Discussion*, **N. Shaw** considered soluble hygroscopic particles affected the rainfall more than insoluble particles in that drops would form below saturation. R. S. R.

1351. Barometric Oscillations in a Cyclone. S. Takaya. *Imp. Marine Obs., Kobe, Japan,* 3. *pp.* 178–186, *Nov.*, 1929. *In English.*

From the barograph records of thirty-three cyclones it appears that minor oscillations of pressure occur of the order of a few mm. in amplitude and an hour in period. Measuring the magnitude of a cyclone by the mean radius of its outermost complete isobar (300–550 km.), it is shown that on the whole the period of these oscillations varies directly with this radius. On the hypothesis that these oscillations are free oscillations produced by waves of expansion (longitudinal waves) in a circular column of air of radius as above, together with certain minor assumptions, their period is calculated and shown to be in substantial agreement with observed facts. More or less corresponding oscillations occur in the anemometer records, for which an explanation on the same hypothesis is advanced. C. A. S.

1352. Atmospheric Optical Phenomenon. R. Gindre. *Comptes Rendus,* 189. *pp.* 749–751, *Nov.* 4, 1929.

The coloured figures observed in sunlight on a bank of clouds at an altitude of 400 to 500 m., as seen from the Pic-du-Midi observatory (altitude 2860 m.), are described. Their form is attributed to intersection by the plane of the clouds of the cone subtended at the observer's eye and having the line joining the observer to the sun as axis. F. S.

1353. Radiation Measurements on the Stolz Alps, Oct., 1927–Nov., 1928. F. Schembor. *Akad. Wiss. Wien, Ber.* 138. 2*a*. 7. *pp.* 497–524, 1929.

Measurements were made with (1) a Michelson–Marten actinometer, (2) an Ångström pyranometer, and (3) an Elster–Geitel cadmium photoelectric call. Values are tabulated to show the influence of solar height, time of day, season of year and cloudiness and the different parts of the spectrum are tested also by using two red and one yellow filters. A comparison with Exner's values shows that the Stolz Alps receive more radiation than Davos in winter and spring but less in summer and autumn. Comparison with Holzapfel's values for other places shows that the values for the Stolz Alps equal those at Arosa in July although 700 m. lower and nearly equal to those at Obir in August and September. R. S. R.

1354. Solar Radiation. W. Gorczyński. *Acad. Polonaise, Sci. et Lettres, Bull.* 8A. *pp.* 410–433, *Oct.*, 1929.

The scope of the paper is confined to giving high values and losses of energy of solar radiation observed in desert regions and tropical mountains. All values are expressed in the Smithsonian scale and give an accuracy of 1 %. The formulæ for calculating and the causes of the loss of solar energy across atmospheric layers are recapitulated briefly. Owing to lack of agreement of observations taken low down and in the more elevated layers of the atmosphere, and the failure of spectrographic determinations, recourse was had to another method, namely, the evaluation of the degree of atmospheric transparency, which is described. Some tables of figures and maxima of solar radiation observed by the author on various sea voyages are given. Tables give results obtained in the desert plains and high mountains of Northern French Africa. The atmosphere is often very clear in the Sahara, particularly during the winter months. Further tables give the degrees of transparency for places in various parts of the earth, and the conclusion is reached that the layers of air above desert regions, and especially in the oases of the Sahara, cause less loss of solar energy than those above the plains of temperate or equatorial regions. The paper concludes with a bibliographical index. T. C. H.

1355. Ozone Determinations without Measurements of Intensity. F. W. P. Götz. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 36–37, 1929.

Cornu gave the relation that the shortest wave-length transmitted varies linearly with the logarithm of the sine of the solar elevation. The author suggests measurements of this wave-length for full illumination and with a known reduction in order to approach the region where the Rayleigh scattering is negligible. From the equations given the thickness and height of the ozone layer can be obtained. R. S. R.

1356. Potential Gradient and Atmospheric Pollution: Influence of "Summer Time." F. J. W. Whipple. *Roy. Meteorolog. Soc., J.* 55. *pp.* 351–360; *Disc.*, 361, *Oct.*, 1929.

This paper gives the diurnal potential gradient curves for the period 1898–1928 and the corresponding records of atmospheric pollution as obtained by means of the Owen's filter since the year 1921. The diurnal potential gradient curve exhibits two maxima and two minima, the first turning point being a minimum. Comparing the summer periods for the years 1898–1916 with the corresponding months of the years 1916–1928, two noteworthy changes took place. During the "summer time" years there has been a clear displacement of the early morning minimum and the forenoon maximum, the turning points being about an hour earlier [G.M.T.]; also the evening maximum of the curve has undergone a distinct decrease in amplitude. The curve of diurnal variation in pollution since 1921 in the summer bears a striking resemblance to the potential gradient curve for the same period, except that the morning minimum and maximum of pollution occur an hour earlier than the corresponding extreme values of pollution. The author gives Simpson's explanation of the two maxima and two minima in the pollution curve in terms of the diurnal curve of smoke production and the curve of atmospheric pollution, and discusses the reasons for the diurnal variations of potential gradient.

W. C. S. P.

1357. Distribution of Ozone in the Atmosphere. S. Rosseland. *Gerlands Beitr. z. Geophys.* 34. 1. *pp.* 50–52, 1929.

By assuming that the ozone occurs in a thin spherical shell, concentric with the earth and of constant thickness and surface density, measurements of the intensity of radiation reaching the earth for different inclinations will give the height of the layer and its equivalent thickness. The author obtains an equation in which no assumption is made regarding the space distribution of ozone except that it is spherically symmetrical with respect to the earth's centre. He considers that the supposition of ozone being only in a relatively thin atmospheric layer depends largely on physical arguments concerning its mode of formation.

R. S. R.

1358. Effect of Ozone on Temperature of Upper Atmosphere. E. H. Gowan. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 57–59, 1929.

The author builds up an equation of radiative equilibrium by considering the total radiation received, and, therefore, re-radiated again, by any layer: $2\int_0^\infty K_\lambda B_{\lambda T_0} d\lambda = \int_0^\infty K_\lambda (S_\lambda + E_\lambda + A_\lambda) d\lambda$, where K_λ is the fractional absorption of parallel rays perpendicular to the layer, $S_{\lambda T_0}$ the black body radiation at T_0A, S_λ the total solar radiation reaching the layer, E_λ the total atmospheric radiation reaching the layer, all at any wave-length λ. The integration is performed by successive approximations, the atmosphere being divided into optical rather than geometric layers. The results so far obtained show that this explanation of the high temperature is adequate, and the temperatures agree fairly well with those deduced from meteors and sound-ranging, but a little further adjustment is required for heights. Possible sources of error are mentioned. In discussing the results **F. Linke** considers the heights too great and remarks on the possibility of "Reststrahlung" being due to the ozone layer.

R. S. R.

1359. Amount of Ozone in the Atmosphere and its Relation to Climatological Problems. A. Ångström. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 62–64, 1929.

The author discusses the absorption by ozone in the ultra-violet, visible and infra-red regions of the solar spectrum and the ratio of this to the total emission. K. Ångström's results indicated that extrapolation of laboratory results to the atmosphere is not reliable, while measurements of nocturnal emission from the earth indicate an increase in the thickness of the ozone layer after nightfall and a rapid decrease near sunrise. He suggests an investigation (1) of nocturnal radiation to connect the diurnal and annual variation with solar activity and the times of maximum and minimum sunspots, and (2) simultaneous measurements of ozone absorption in the ultra-violet, visible and infra-red regions and the amount of ozone as found by Chalonge's modification of Dobson's method for nocturnal radiation.

R. S. R.

1360. Earth's Temperature Gradient. F. M. Gentry. *Science*, 70. *pp*. 332–334, *Oct*. 4, 1929.

The use of a linear gradient is unsatisfactory because it leads to large errors even at shallow depths. Two equations are deduced, one based on the assumption that all surface heat is produced radioactively, and both agree satisfactorily with measurements in deep wells. W. A. R.

1361. Earth's Elastic Constants. A. Prey. *Gerlands Beitr. z. Geophys*. 23. 4. *pp*. 379–429, 1929.

The formulæ, devised by Schweydar and Herglatz, for the elastic tides of a heterogeneous earth cannot be applied to a homogeneous earth, because in this case all elastic strains vanish. The cause of this behaviour is investigated and new formulæ are developed. W. A. R.

1362. Development of the Wave Conception. Part II. K. Uller. *Gerlands Beitr. z. Geophys*. 24. 2–3. *pp*. 309–334, 1929.

Previous work is first discussed at length [see Abstract 2388 (1929)], following which it is shown that solution methods hitherto applied to wave subjects not only contain undeniable contradictions and inadequate reasoning, but are entirely indefinite. The various sections of the paper deal with the refraction theory, the Fermat principle, the species and number of possible waves, wave incidence, progressive waves, oscillations, wave production in liquids and gases from stationary conditions, and general treatment of field propagation. A solution is promised in a future paper. The present paper concludes with a literature Bibliography. H. H. Ho.

1363. Bruns' Term and the Gravity Anomaly. W. D. Lambert. *Gerlands Beitr. z. Geophys*. 24. 4. *pp*. 371–377, 1929. *In English*.

Two recent articles by Hopfner [see Abstracts 2982 and 3290 (1929)] are examined. His conclusion as to the relative magnitudes of the direct effect of irregularities in the distribution of matter and the corresponding indirect effect due to a warping of geoid appears to be unfounded, the error arising from the omission of an important term in the calculation of the direct effect. It is shown that the free-air gravity anomaly and the elevation of the geoid above the spheroid are in general of the same sign. The usual interpretation of gravity anomalies, therefore, holds good, also the usual arguments based on them in favour of the existence of fairly complete isostatic compensation. Replies by **F. Hopfner** and **W. D. Lambert**, *ibid*, pp. 378-380. A. D.

1364. Relation between Distribution of Gravitational Anomalies and Origins of Earthquakes in Japan. C. Tsuboi. *Imp. Acad. Tokyo, Proc*. 5. *pp*. 326–329, *Oct*., 1929. *In English*.

Gravitational anomalies (gravity as measured less gravity as calculated by the Helmert formula) have been plotted on a map of Japan, as also the numbers of earthquakes recorded in the past fifteen years. Of the four areas of marked negative anomaly, three coincide with areas of maximum number of earthquakes, while the fourth is a very mountainous area where the large anomaly may be due to the effect of isostasy. C. A. S.

1365. Complex Seismic Waves. A. Belluigi. *Gerlands Beitr. z. Geophys*. 23. 3. *pp*. 233–236, 1929. *In Italian*.

The existence of composite waves in anisotropic media has been suspected. It is now shown that such complex waves must be considered, as well as the known P and S waves, in order to harmonise certain mathematical and experimental demands. W. A. R.

1366. Variation of Zone of Macroseismic Activity in the Pacific Ocean. N. Miyabe. *Tokyo Univ. Earthquake Research Inst., Bull.* 7. *pp.* 261–268, *Sept.*, 1929. *In German.*

Table and figure show a marked variation or wandering of the macroseismic zone of the Pacific Ocean. Moreover, the changes in the position of the pole of the active zone harmonise with that of the geographical pole. The latter changes, of course, in harmony with sunspot activity. W. A. R.

1367. Tidal Harmonic Constants at Several Ports in Japan. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.* 3. *pp.* 167–177, *Nov.*, 1929. *In English.*

Harmonic analyses have been made of the tidal observations at the ports of Sakai (on the Sea of Japan), Toba (on the Pacific coast), Uwazima and Simoto (on the channel between the Sea of Japan and the Pacific), and Palau (Caroline Islands) according to Doodson's method [see Abstract 761 (1922)], and tables showing the harmonic constants (H in degrees and *k* in cm.) given for each of the 60 components for each port. C. A. S.

1368. Isothermal Oceanic Eddy Cones. J. Thoulet. *Comptes Rendus*, 189. *pp.* 940–942, *Nov.* 25, 1929.

From an examination of the data for density and temperature of the ocean collected by the Challenger expedition it is concluded that there occur vast isothermal eddies in the shape of an inverted cone. One near Tahiti is limited by the isotherm 2·1–2·2°, the temperature of the surrounding water being 1·8°, its base (480 miles in diameter) is at a depth of 2560 m., and apex at 3650 m., the depth of the ocean averaging 4900 m. and surface temperature 26°. Another similar eddy occurs near Tristan da Cunha. C. A. S.

1369. Geomagnetics. A. Belluigi. *Pont. Accad. Sci. N. Lincei, Atti*, 82. *pp.* 357–363, 1928–1929. *Supplement.*

A simple method of calculating the influence of magnetic masses. The method permits, at any rate in certain cases, the analysis and interpretation of the results of magnetic measurements in mineral prospecting. A. D.

1370. Use of Complex A.C. Compensators for Geodetic Investigations. W. Geyger. *Arch. f. Elektrot.* 23. *pp.* 109–118, *Nov.* 5, 1929.

The author discusses the earlier methods of using alternating currents to discover the nature and distribution of minerals in the soil and the necessity for using a compensator to overcome the inherent difficulties in the method. The apparatus and methods of use are explained, equipotential lines being plotted on a chart. A comparison of this chart with that for the normal picture for homogeneous ground will give the position and amount of the better or poorer conducting layers. Application of the results is a matter of practical experience. Systematic development of the method has led, under difficult geological conditions, to successful results, and promises to be of considerable financial importance. R. S. R.

1371. Structure of the Hα Line, and Period of Rotation of the Sun's Chromosphere. G. Abetti and B. Nováková. *Accad. Lincei, Atti*, 10. *pp.* 227–230, *Sept.*, 1929.

In earlier papers the writer reported that spectrograms taken with the

Tower telescope at Arcetri showed an asymmetry of the line Hα at the sun's limb. Later measures confirm this, and also that the asymmetry is constant at all latitudes. The period of rotation, which has now been determined from this line, is found to be greater for Hα3 than for Hα2, which is at a lower level. The asymmetry seems to be slightly greater on the east limb than on the west. The limb-effect has also been found from this line, and from four metallic lines in the same region. It is considerably greater than that found by St. John from lines of shorter wave-length, but it is probable that limb-effect is partly a function of intensity and wave-length. M. A. E.

1372. Effect of Curvature of the Solar Surface upon the Position of the Sunspot near the Limbs. M. Notuki. *Phys. Math. Soc. Japan, Proc.* 2. *pp.* 102–107, *Oct.*, 1929. *In English.*

The correction for the position of a sunspot, due to refraction by the solar atmosphere and depth-parallax of the sunspot, is usually calculated by Cassini's formula. The author directs attention to the necessity for taking into account curvature of the sun's surface near the limbs as an additional correction, and concludes that the correction due to the two former causes, *i.e.*, refraction and depth-parallax, is small and almost negligible after elimination of the correction due to curvature. J. S. G. T.

1373. Radiation and Temperature of the Sun. W. E. Bernheimer. *Monthly Weather Rev.* 57. *pp.* 412–417, *Oct.*, 1929.

The variations in the solar constant found by Abbot are discussed, and the changes in intensity of ultra-violet radiation. The criticisms of Marvin and of the writer are set forth, and it is considered probable that the apparent fluctuations in the sun are really caused by changes in the earth's atmosphere. M. A. E.

1374. Total Solar Eclipse of May 9, 1929. Reports of the British Expeditions. *Roy. Astron. Soc.*; *M.N.* 90. *pp.* 121–137, *Nov.*, 1929.

Jackson, who went from Greenwich Observatory to Alor Star, reports that cloudy conditions prevented any stars being visible on the plates taken to test the Einstein displacement, but that photographs of the corona prove that its form was of intermediate type, and show streamers to a distance of a radius from the limb, and a very large prominence. Carroll, who went from the Solar Physics Observatory, Cambridge, to the same place, reports that no photographs susceptible of exact measurement were taken with any of his instruments, owing to cloud; but it was ascertained that useful results could be obtained with the interferometer, and also with the moving-film camera under better conditions. Stratton and Melotte, also Royds from India, went to Pattani in Siam, but were unable to carry out any part of their programmes, owing to cloud. Times of second and third contact and meteorological changes were observed on board H.M.S. "Iroquois," by J. D. Nares, from near Penang. The computed times given in the Nautical Almanac were respectively $0^s\cdot 0$ and $1^s\cdot 6$ later than those observed. M. A. E.

1375. Radial Limitation of Sun's Magnetic Field. T. G. Cowling. *Roy. Astron. Soc.*, *M.N.* 90. *pp.* 140–154, *Nov.*, 1929.

The theories of Ross Gunn and of Chapman as to the limitation of the sun's magnetic field are discussed, and both are shown to be defective. In a steady state neither Ross Gunn's nor Chapman's effects appear, owing to a masking which is caused by the pressure gradient. New mechanical equations are set up, and the modification of the Pannekoek-Rosseland field due to the magnetic field is found. The theory is one of steady states, and it may break down if the temperature gradient of the sun is considered. M. A. E.

1376. Revision of Newcomb's Occultation Memoir. H. S. Jones. *Roy. Astron. Soc., M.N.* 90. *pp.* 71–104. *Nov.*, 1929.

Newcomb's Memoir *Researches on the Motion of the Moon*, Part II, published in 1912, contained a derivation of the mean motion of the Moon and of other astronomical elements, based upon observations of occultations extending from 1672 to 1908. Hansen's Tables were used as a basis for computation. Since the completion of Brown's Tables of the Moon, and following upon the reduction and discussion of the Cape observations of occultations from 1880 to 1892, the revision of Newcomb's memoir was begun four years ago. The results are now summarised, and details of the computations will be published in the *Cape Annals*. Newcomb's value of the secular change of the obliquity of the ecliptic requires a correction of $-0''\cdot30$, due to error in his adopted mass of Venus, and his equinox at epoch 1850 is corrected by $-0^{s}\cdot047$. M. A. E.

1377. Relations between Synodic Periods in Satellite Systems. L. W. Topham. *Observatory*, 52. *pp.* 325–329, *Nov.*, 1929.

The periods of certain satellites are very closely commensurable with those of certain others, especially satellites I, II, and III of Jupiter, and Mimas and Enceladus in the system of Saturn, whose periods are respectively the halves of those of Tethys and Dione. Commensurabilities of less exactness are found in the four outer planets (satellites of the sun), the period of Saturn being very closely two and a half times that of Jupiter, and so on. The other bodies of the solar system do not come under this simple rule, but when the number of satellites is greater than two, their periods seem to be determined by a closely analogous rule. Thus, with the satellites of Uranus, the rest of the satellites of Saturn, and the four inner planets, there is a tendency for the synodic periods, taken in pairs, to be commensurate with that of the two most massive satellites, which is, therefore, the dominating period, and to a less degree with those of pairs of smaller satellites. A suggested explanation of this fact of approximate commensurability is that two comparatively large satellites may have been first formed out of a system like Saturn's rings; that these two determined the birth of others at a distance which would give rise to a synodic period commensurate with their own, and that the periods of the smaller bodies have shortened slightly owing to the action of a resisting medium, which would naturally have most effect on the nearest and smallest. M. A. E.

1378. Theory of Asteroids of Type $(p+2)/p$. A. Rasdolsky. *Arkiv. f. Mat., Astron., och Fysik, Stockholm*, 21A. 18. [28 *pp.*], 1929. *In German.*

Von Zeipel has developed the theory of asteroids on the basis of Poincaré's methods for integration of equations. In the present paper this theory is applied to calculate the perturbations of asteroids of one special type, including the secular, long-period and short-period perturbations. The theory is tested with Hestia, and compared with observations from various observatories between the years 1873 and 1909. It is found to represent the actual motions of Hestia with satisfactory exactitude during the 36 years. M. A. E.

1379. Calculation of the Colour Index of Stars. G. Tiercy. *Archives des Sciences*, 11. *pp*. 260–269, *Sept.–Oct.*, 1929.

Extends formulæ previously developed [see Abstract 1475 (1929)] to account for the fact that the effective wave-lengths are not the same when considering a weak and a strong luminous source. It is shown that the effective wave-lengths, whether visual or photographic, are a function of the solar magnitude of the source under consideration. Therefore the formulæ for the visual and photographic magnitudes must contain a term in which the variation is accounted for. The colour index, which is the difference between the photographic and visual magnitudes, is given by the equation $I = 7210/T + (a - 58.\Delta m/T)$ where T represents the temperature, a is a constant-0·64 and Δm is the variation of magnitude from magnitude 5. Finally, an approximate form is developed in which it is only necessary to know the magnitude variation, the visual magnitude and the radius. R. C. F.

1380. Colour Temperatures of 24 Stars, Suitable for Use as Spectrophotometric Standards. W. M. H. Greaves, C. Davidson and E. Martin. *Roy. Astron. Soc., M.N.* 90. *pp*. 104–112, *Nov.*, 1929.

In previous papers [see Abstracts 496 (1926) and 2237 (1927)] some results have been given of deducing effective temperatures of stars from their colours by means of Planck's formula; and in order to facilitate these determinations 24 stars, fairly evenly distributed over the northern sky, have been selected to be used as standards, and have been intercompared in pairs at equal altitudes so as to obtain the gradients of the whole set relative to a common zero. Results are here given of the observations of these stars, and considerable progress has been made in determining the gradient of others by comparing them with the standards. It is noted that among stars of spectral types B0 to B2 the dispersion in gradient and temperature is very large. M. A. E.

1381. Temperatures of Giant and Dwarf Stars. L. Hufnagel. *Harvard Coll. Obs., Circ. No.* 343. [10 *pp*.], 1929.

Harvard stellar photographs taken for the Draper catalogue are used to determine the difference in temperature of giant and dwarf stars and to test the Harvard plates for spectrophotometric work with the Schilt photometer. Photometric methods for use with objective prism spectra have been discussed by Payne and Hogg [see Abstract 1215 (1928)]. The present work shows that good Harvard plates, measured with the Schilt photometer, may be used for statistical work. Differences in temperature of giants and stars, determined by the use of this photometer, agree with other published results, except those of Storer for KO stars. J. S. G. T.

1382. Masses, Luminosities and Effective Temperatures of the Stars. E. A. Milne. *Roy. Astron. Soc., M.N.* 90. *pp*. 17–54, *Nov.*, 1929.

Physics makes progress by discarding ideas corresponding to quantities which can never be observed: thus, the principle of relativity takes the place of the "unobservable" velocity of a system through the ether. It may be necessary to introduce into our equations symbols corresponding to unobservables, but the physical content of the assertion which results from a piece of mathematico-physical reasoning must be a relation between observables only. This method is here applied to the structure of the stars, whose interior can never be directly observed. The standpoint is philosophically different from that of Eddington, and the main conclusions are that it is not possible to infer from the observed masses, luminosities and temperatures that the interiors of stars are necessarily composed of perfect gas, nor to deduce the value of the absolute coefficient for the stellar interior. Instead, it is inferred that the stars are indistinguishable observationally (white dwarfs excepted) from a single homologous family with a common density-distribution. This result may be modified by increasing knowledge of the stars, but the method is independent of special results, and is the feature to which importance is attached. M. A. E.

1383. Integral Theorems on the Equilibrium of a Star. E. A. Milne. *Roy. Astron. Soc., M.N.* 89. *pp.* 739–750, *Oct.*, 1929. *Supplement.*

It is of interest in the theory of stellar equilibrium to develop theorems which are true for any star, independent of special assumptions as to composition, state, distribution of energy generation, etc.; and certain minimal theorems of this character were formulated by Eddington, under varying degrees of generality, in his *Internal Constitution of the Stars*. In the present paper a general theorem, involving integrals of pressure and mass through any star, is stated and proved. Particular cases of it yield expressions for the mass, the gravitational energy and the mean value of gravity with respect to mass as integrals of the total pressure. A lower limit is deduced for the central pressure in any star. Lane's law is stated and proved in its most general form, and the weighting of "$1 - \beta$" through a star to give the correct mass is obtained. A number of theorems are proved for stars built on the polytropic model of Emden. M. A. E.

1384. Ballistic Theory of Light Tested by Law of Areas in Orbits of Telescopic Double Stars. C. Cannata. *Accad. Lincei, Atti*, 10. *pp.* 173–178, *Aug., and pp.* 358–361, *Oct.*, 1929.

It has been stated as evidence against the ballistic theory of light that observations of telescopic double stars fail to show any evidence of the influence of the motion of source upon the velocity of light propagation. But Lorentz and others have questioned whether the effect, if it exists, would be visible with our present means of observation, in particular the deviations from the law of areas (Kepler's second law). It is here shown by exact mathematical calculation that the maximum deviations to be expected on the ballistic hypothesis are distinctly less than the probable errors of observation, even with the best modern methods by interferometer. Even if the perturbations of orbit which would result on the ballistic hypothesis were perceptible by observation, they would not appear to conflict with the law of areas, since such perturbations can be accounted for simply by altering the orbit deduced from observation, either in its eccentricity or its orientation, so that the true orbit remains unrecognised. In constructing a double-star orbit the law is not proved, but assumed from the beginning. M. A. E.

1385. Variable Star SX Herculis. M. Merola. *Accad. Lincei, Atti*, 10. *pp.* 349–353, *Oct.*, 1929.

This variable was discovered by Miss Leavitt in 1907, and from Luyten's observations it would appear to vary from class K2 to Mb. It is usually considered as intermediate in type between the Cepheids and the long-period variables Md. It was observed at Capodimonte from August 1927 to December 1928, and the irregularities in period and light-curve which were noted by other observers are in part confirmed.

M. A. E.

1386. Periodical Displacement of the Pole Star. A. Danjon. *Comptes Rendus*, 189. *pp.* 841–843, *Nov.* 18, 1929.

Confirmation of the existence of a periodical displacement of the pole star may be sought by measurements in which the companion of the star serves as reference star. The author has discussed observations made since 1802. Besides an orbital motion a relative secular motion of the pole star with reference to its companion was investigated with the following results: (1) The distance of the pair does not show any secular variation. The angle of position increases by 0·7° a century. (2) There are two hypotheses as to the period: 30 years (Moore, radial velocities) and 33 years (E. Esclangon, meridian observations). There is a systematic variation of the coordinates as a function of the time. The results furnished by the period of 33 years are more regular. The period of 30 years gives a very flattened apparent trajectory corresponding to a probably very eccentric orbit. The period of 33 years gives a well-defined apparent ellipse. On both hypotheses there is confirmation that the right ascension of the pole star varies periodically by a quantity comprised between a second of time and a second and a half. The present time is particularly favourable for commencing systematic measurements of the pole star either photographically or micrometrically, keeping the companion as reference star.

J. J. S.

1387. Relation between Velocity Ellipsoid and Rotation of Galaxy. B. Lindblad. *Arkiv. f. Mat., Astron., och Fysik, Stockholm,* 21A. 15. [7 *pp.*], 1929. *In English.*

In previous papers [see Abstracts 2954 (1928) and 1479 (1929)] it has been shown that, if we assume the frequency function of the components of stellar velocities in the galactic plane to be that of a steady state involving a considerable momentum of rotation, there exists a close relation between the ratio of the two axes of the velocity ellipsoid of relative velocities in the galactic plane and the rotation effects in stellar motions recently found by Oort. If a is the axis which lies in the direction towards the centre of the stellar system, and b the axis in the tangential direction, we have $b/a = 1 - A/\omega$, where A is the coefficient determining the rotation effect in the linear velocities for unit distance, and ω is the angular velocity of rotation. The present paper shows that this relation holds good under fairly general conditions, even when dealing with a sub-system for which the general dispersion and the "asymmetrical" drift are considerable, thus enhancing greatly the importance of the equation. Also, we may use it for computing the angular speed of rotation ω, instead of being compelled to use the value called B in Oort's system of notations, which must always be difficult to fix with accuracy. Comparison is made with observed stellar motions, and it is found that B stars and A stars with small proper motion do not completely conform with theory, probably because they cluster together in more or less closed formations. The planetary nebulæ appear to conform well. The importance is stressed of simultaneous determinations of velocity-ellipsoid and rotation-effect from observed motions in the line of sight.

M. A. E.

1388. Planetary Theory with True Longitude as Independent Variable. E. W. Brown. *Roy. Astron. Soc., M.N.* 90. *pp.* 3–17, *Nov.*, 1929.

In his theory of the Trojan group of asteroids, the author used the true longitude reckoned in the manner usual in the planetary theory, *viz.*, to the node along the plane of reference and then along the osculating orbit. He finds that such work is simplified by the use of the true longitude reckoned wholly in the osculating plane, that is, from a "departure point" in that plane. He points out the advantages gained by this method, and applying the new formulæ to the mutual perturbations of Jupiter and Saturn shows that they give a high degree of accuracy in the result. M. A. E.

1389. Internal Circulation in Rotating Stars. A. S. Eddington. *Roy. Astron. Soc., M.N.* 90. *pp.* 54–58, *Nov.*, 1929.

Conditions in a rotating star are never spherically symmetrical, and the flow of radiation will in general tend to heat the polar and equatorial regions unequally. This unequal heating maintains currents circulating in the meridian planes, but it is here shown that such circulation can only be slow. It is on a far smaller scale than that postulated by Bjerknes' theory of the sunspot period, or by Rosseland in connection with variable stars. M. A. E.

1390. Effect of Distribution of Density on the Period of Pulsation of a Star. J. C. P. Miller. *Roy. Astron. Soc., M.N.* 90. *pp.* 59–64, *Nov.*, 1929.

Extends Eddington's calculations of the period of adiabatic pulsation of a gaseous star for a model star corresponding to $n = 3$ to models $n = 2$ and $n = 4$, thus allowing of a comparison which will show how the period is affected by the degree of concentration of the mass towards the centre. Assuming the effective ratio of the specific heats for the matter and radiation to be constant, it is found that model $n = 2$ gives a longer period and $n = 4$ a shorter period than that given by $n = 3$. Approximately similar results are obtained by taking into account the varying ν, replacing it by an appropriate average value. Eddington had to adopt a low value of Γ in order to make his model fit the observed periods of the Cepheid variables. By changing the value of n to 2 the observations are fitted by a value of Γ nearer to 5/3, the usually accepted value. This lower value of n indicates that in the Cepheid stage actual stars are less concentrated towards the centre than the model $n = 3$. This assumes that the general value of Γ holds for Cepheids which may, however, be incorrect. R. C. F.

1391. Irregularities of Period of Long-Period Variable Stars. A. S. Eddington and S. Plakidis. *Roy. Astron. Soc., M.N.* 90. *pp.* 65–71, *Nov.*, 1929.

The light fluctuations of long-period variables have a well-marked periodicity, complicated by superposed irregularities. Different types of irregularity are suggested as possible, including correlation between successive periods, and periodic causes. Two stars are discussed for which long-continued observations are available, *o* Ceti and γ Cygni, and it is found that the observations agree with the hypothesis of purely accidental fluctuations, coupled with a term which probably represents errors in fixing the time of maximum. In the case of *o* Ceti, an apparent periodicity of nine years is evidently the result of incompleteness of data, many maxima being unobserved. M. A. E.

1392. Moving Foreground of Large Magellanic Cloud. W. M. Smart. *Roy. Astron. Soc., M.N.* 90. *pp.* 112–120, *Nov.*, 1929.

Recently Luyten of Harvard Observatory investigated the proper motions of 500 stars in the region of the Large Magellanic Cloud, and discussed these statistically, with the following results: (*a*) the proper motions show very clearly the effects of streaming in the expected directions; (*b*) the proportion of Drift II stars to Drift I stars is apparently abnormally low. The proper motions are here submitted to a more detailed analysis, and it is found that the proportion of Drift II to Drift I stars is not far removed from the usual proportion found in other parts of the sky. The velocities of the two drifts appear to be entirely normal. Finally, the distribution of the proper motions according to magnitude is dealt with, and the observational evidence is found to accord with the assumed formula for distribution of stars in space which was considered by the writer in previous investigations. It is most desirable that the proper motions of *all* stars photographed in any region should be obtained as accurately as possible, since in the search for the true law of stellar distribution very distant stars with small proper motions clearly play a very important part. M. A. E.

1393. "Null-Effect" in the Influence of Absolute Magnitude on Stellar Spectra. E. A. Milne. *Harvard Coll. Obs., Circ. No.* 870. *pp.* 1–4, *Oct.* 1, 1929.

The theories of high-temperature ionisation and the dependence of photospheric absorption coefficient on electron-pressure predict definite changes in the spectra of stars with changes in the value of surface-gravity g. These changes are due to interplay of two tendencies: (1) the increased effective mass of the atmospheres of giants as compared with dwarfs; (2) the effect of altered pressure, consequent on change of g, on ionisation. It is pointed out that on the high-temperature side of a maximum the strengths of lines as affected by atmospheric thickness and ionisation should be ultimately independent of g, the physical reason being that the effect of reduced g giving increased mass in the atmosphere is almost exactly cancelled by the increased ionisation causing reduction in the number of atoms in the given state of ionisation. Typical cases are examined. Calculation shows that for hydrogen the curves of number of neutral or neutral excited atoms plotted against T for different values of g merge together shortly after 10,000°, for Si^{+++} lines at about 31,000°, and for C^{+} at about 8000°. From these temperatures onwards, the curves for different g are in each case completely indistinguishable. Therefore, any line-widening effect on the high-temperature side of a maximum (for instance, in the Balmer lines for the hotter stars) must be due to other causes than atmospheric thickness or ionisation, because the effect of the first is cut out by the effect of the second. This result should be of use in disentangling the causes affecting line-widths at high temperatures. M. A. E.

1394. Spectroscopic Study of Two Visual Binary Systems. Y. C. Chang. *Astrophys. J.* 70. *pp.* 182–190, *Oct.*, 1929.

The star 51 ξ Scorpii was discovered by W. Herschel in 1782 to be a triple system, consisting of a close binary and a more distant companion. He also discovered 2 Eta Coronæ Borealis to be double, in 1781.

The two components of this system never come very close together, and three revolutions have been completed since discovery. The velocity-curves of these two binaries are here given, with their spectroscopic elements, and the elements of their visual orbits, derived from spectrograms taken at Yerkes and Lick. The inclination of the orbit of the first is found to be positive, of the second negative. It is very desirable to study the orientation of orbital planes of visual binaries, in order to discover whether they show any parallelism to the Galaxy, or any other plane, and whether they tend to intersect at the centre of the Galaxy, or at any other point. This has been done by several observers, using orbits with ambiguous inclinations. Here only these two binaries and fourteen others, the sign of whose orbits have been determined, are used. [See also following Abstract.] Hence the data, though scanty, are certain, and the result points clearly to a random distribution. M. A. E.

1395. Orientation of Orbit-Planes of 16 Visual Binaries having Determinate Inclinations. Y. C. Chang. *Astron. J.* 40. *No.* 932. *pp.* 11–15, *Nov.* 27, 1929.

The problem previously discussed briefly [see preceding Abstract] is here presented in greater detail, and the results of other investigators are given. These are varied and sometimes diametrically opposite, and the writer suggests that this fact in itself is an argument for random distribution of orbital planes. Random distribution agrees better with the fission theory of the origin of binaries than with the capture theory or the nuclei theory. M. A. E.

1396. Spectroscopic Investigation of β Cephei. R. N. v. Arnam. *Dominion Astrophys. Obs. Victoria, Publ.* 4. 12. *pp.* 171–178, 1929.

The varying velocity of this star was discovered by Frost and Adams in 1902, and the period was found to be about 4½ hours. Both light and velocity curves are variable. The work of different observers is briefly summarised, and the results of a new investigation are given. M. A. E.

1397. Line Intensities in Nebular Spectra. H. H. Plaskett. *Dominion Astrophys. Obs. Victoria, Publ.* 4. 14. *pp.* 187–207, 1929.

The spectrophotometric determination of line intensities in nebular spectra gives promise of valuable clues to the physical nature of nebulæ, which, as Eddington has shown, are transparent to all their observed emission lines. An account of the methods used is here given, and a table of results for eight nebulæ. From these it is proved that the Balmer spectrum is formed on recombination of the positive hydrogen ion and a free electron; the fraction of atoms which capture an electron on a given state has been deduced; and Bowen's hypothesis is confirmed that the forbidden lines of O++ are emitted after excitation by an inelastic impact with a free electron. M. A. E.

1398. Relative Intensities of Nebular Lines. J. H. Bartlett, Jr. *Phys. Rev.* 34 *pp.* 1247–1262, *Nov.* 1, 1929.

It is proved rigorously for multipole radiation that the transition $j = 0 \rightarrow j = 0$ cannot occur. The relative intensities of the lines of the multiplet $^2P \rightarrow {}^2D$ are calculated and are not in agreement with experiment, in that the weaker lines are not observed. The relative intensities of the intercombination lines comprising the multiplet $^1D \rightarrow {}^3P$ are calculated, using in part the Darwin-Pauli theory of the spinning electron as applied by Houston to the study of intercombination lines. The line $^1D_2 \to {}^3P_2$ always is strongest according to the calculations, and the experiments confirm this. The line $^1D_2 \to {}^3P_1$ is about half as strong, which also checks experiment. The intensity of $^1D_2 \to {}^3P_0$ varies, however, from zero to a value of the same order of magnitude as that of $^1D_2 \to {}^3P_1$. This is in disagreement with experiment, in that the line is not observed. This is the same sort of disagreement as for the multiplet $^2P \to {}^2D$. It is concluded that Bowen's hypothesis, attributing the emission of the "forbidden" nebular lines to quadripole radiation, is substantiated to some extent, but not fully. The discrepancies between theory and experiment may arise from the simplifying assumptions introduced. AUTHOR.

1399. Structure and Opacity of a Stellar Atmosphere. E. A. Milne. *Roy. Soc., Phil. Trans.* 228. *pp.* 421–461, *Nov.* 12, 1929. *Bakerian Lecture.*

Broadly speaking, the photosphere of a star gives rise to its continuous spectrum and the reversing layer to the absorption lines. If we can determine the general capacity of these regions, this will determine the depth we see into a star, and so the physical conditions under which the observed spectral phenomena originate. The abstract problem is: Given the surface gravity and the mean intensity of radiation over the stellar disc, and given also the ultimate chemical composition of the material, to determine the distribution of temperature, pressure, density, ionisation and chemical composition in the layers, and to determine also the complete intensity-distribution both in angle and frequency of the emergent radiation. The practical problem is to some extent the converse one of inferring the temperature, etc., from the observed emergent radiation, *i.e.*, from the spectra. The researches here summarised are attempts to obtain definite quantitative laws for the calculation of intensities of spectral lines as functions of surface gravity and radiation-intensity. A knowledge of these laws leads to a knowledge of the pressures in stellar atmospheres, and of the coefficient of general opacity. And this makes possible a detailed calculation of the physical state of the photospheric layers of a star. Formulæ are derived for the general case and applied to the Sun and Capella. Tables of pressures, temperatures, temperature gradients and values of absorption coefficients are given for various heights. M. A. E.

1400. Spectrophotometric Study of Class A Stars. Emma T. R. Williams. *Nat. Acad. Sci., Proc.* 15. *pp.* 832–834, *Nov.*, 1929.

The paper is a synopsis of the detailed results given in *Harvard Circular* 348, and shows briefly that (1) The total energy absorption of the K line of Ca+ is found to be a good index of stellar temperature from class B8 to F0. (2) The Henry Draper classification is a surprisingly accurate index of temperature from A0 to F0. (3) Among stars of any given temperature from B8 to A2 the contour of the hydrogen lines depends on the luminosity and gives a fairly reliable criterion for absolute magnitude in the range. (4) The "peculiar" A stars are satisfactorily explained. (5) There is considerable apparent variation in colour index with season, stars appearing redder in the summer months. J. G. H. B.

LIGHT.

1401. General Application of Fechner's Law in Colour Sensation. W. Peddie. *Nature*, 124. *pp.* 791–792, *Nov.* 23, 1929.

In the matter of the sensation of light, quantity and quality must both be dealt with, and tridimensional vectors are appropriate to its geometrical representation. Taking two luminous sensations as represented by vectors α and β of this nature, the author points out, after mathematical treatment, that an expression can be arrived at which satisfies the simple form of Fechner's law:

$$Q = \log q = \log \frac{T\beta}{T\alpha} + \log (UV\alpha\beta)^{2\theta/\pi},$$

where Q is the quaternionic operator $\beta\alpha^{-1}$, but that this expression is in opposition to Abney's law. By taking other possibilities into account, however, it is possible to arrive at

$$Q' = \log \left(\frac{T\beta}{T\alpha}\right)^2 + \psi\frac{4\theta_1}{\pi}\cdot\gamma + 2(\theta_2 - \theta_1)UV\beta\gamma,$$

where ψ is the angle between the planes $(\beta,\gamma,)$ and $(\alpha,\gamma,)$. Being the white vector, the third term represents the sensation of saturation as we pass from α to β, and the second term gives the corresponding change in the sensation of hue. J. G. H. B.

1402. Theory of Total Reflection. J. Picht. *Ann. d. Physik*, 3. 4. *pp.* 433–496, *Nov.* 6. 1929. *Phys. Zeits.* 30. *pp.* 905–907, *Dec.* 1, 1929.

In the usual mathematical treatment of total reflection a contradiction occurs, for it leads to the result that whilst nowhere does a passage of energy from the first to the second medium occur, yet in the second medium a lasting energy current parallel to the surface of separation exists. Whence this energy current comes is not explained by previous mathematical theories, though many experiments show that it exists. In the author's treatment of total reflection, and using the formulæ previously given by him for the refraction of a bundle of rays of limited aperture at a plane surface of separation, this difficulty disappears. In the first place a cylindrical incident wave is considered. The occurrence of a streaming of energy into the second medium is so produced that it gives at the plane of separation of the two media places at which, with very small bending towards that surface by temporary means, lasting energy passes over from the first to the second medium, which then at other places of the plane of separation flows back again into the first medium. The energy passing to and fro across the plane of separation is of the order of magnitude of the incident energy. The passage from cylindrical waves to plane waves is discussed, and here also similar transfer of energy occurs. By the mathematical treatment formulæ are obtained which are expressed as the generalisation of Fresnel's integrals. On the basis of these integrals a generalisation of Cornu's spiral was found advantageous for the discussion of the energy relations. Formulæ are given for the calculation of these generalisations. J. J. S.

1403. Index of Refraction of Damp Air and Optical Determination of Lapse-Rate. D. Brunt. *Roy. Meteorolog. Soc., J.* 55. *pp.* 335–340, *Oct.*, 1929.

By a mathematical treatment based on the formula $(\mu - 1)/\rho$ = constant (given by Gladstone and Dale) the author deduces an expression for the refractive index of damp air at all states of temperature, pressure and vapour pressure, and from this arrives at the value of the change in the value of μ for a change in temperature at constant pressure, and shows by an example that a refraction effect which might be interpreted as due to a lapse-rate of 2° C./100 m. might be due to a lapse-rate of relative humidity at the rate of 33 % per 10 m. An equation of temperature is arrived at $T'' - T = \frac{1}{3}(T' - T)$, whereby the value of T'', the temperature of dry air whose index of refraction is the same as that of damp air at temperature T, can easily be computed by using the values of T', the virtual temperature, which are available in the tables. In astronomical work it is found that the effect of refraction is slightly to elevate a star, and though the effect of water vapour is small and probably not of importance in most cases, it may be appreciable under certain circumstances, and it is quite probable that to this effect is due some of the anomalies observed in survey work in measuring the dip of the horizon. J. G. H. B.

1404. Wave Optics of Beams of Finite Aperture, and Optics of Moving Bodies. J. Picht. *Zeits. f. Physik*, 58. 9–10. *pp.* 667–695, 1929.

Reflection and refraction of a beam of finite aperture from a plane either stationary, moving in the direction of its normal, or rotating, are dealt with on the basis of the "phase condition" which demands that incident, refracted and reflected waves are in the same phase at all places in the boundary plane, and at all times. The work is based on the author's previous papers. The results obtained for the rotating mirror are compared with the theory of H. A. Lorentz, and with the relativistic treatment of the problem. In the case considered the focus is 0·03 mm. from its position when the mirror is at rest according to the relativistic formula, and 0·06 mm. according to the Lorentz formula; both these results differ from that given by the author's theory, but experimental difficulties have proved to be such that it has been impossible to decide between the theories practically. H. N. A.

1405. Refraction of Rays at the Boundary of a Moving Medium. D. J. Eropkin. *Zeits. f. Physik*, 58. 3–4. *pp.* 268–273, 1929.

An equation is obtained giving the change in length of a light wave due to refraction at the boundary of a moving medium, thus leading to an expression for the law of refraction at such a boundary. A. C. M.

1406. Kerr Effect in Gases and Vapours. H. A. Stuart. *Zeits. f. Physik*, 59. 1–2. *pp.* 13–34, 1929.

The double refraction in an electric field (Kerr effect) is measured for methyl bromide, methyl chloride, ethyl chloride, methyl ether and sulphur dioxide, using potentials of about 10,000 volts. A source of error which may have entered into previous work with the Brace compensator is pointed out. The strain ellipsoid is discussed for each compound, and in the case of ethyl chloride it is concluded that the electrical moment is directed at an angle to the major axis of the strain ellipsoid. This angle is probably between 5° and 10°. J. H. A.

1407. Dispersion of Electro-Optical Kerr Effect in the Ultra-Violet. G. Szivessy and A. Dierkesmann. *Ann. d. Physik,* 3. 4. *pp.* 507–535, *Nov.* 6, 1929.

The measurement of the dispersion of the Kerr constant in the visible and ultra-violet spectrum has been made for five different liquids, *viz.*, chlorobenzene, hexane, carbon tetrachloride, toluene, and *m*-xylene, whence it is shown that the quantitative course of dispersion is not correctly afforded by the so-called Havelock formula. H. H. Ho.

1408. Absorption and Rotatory Dispersion of Tartaric Acid and Alkaline Tartrates. G. Bruhat and R. Legris. *Comptes Rendus,* 189. *pp.* 745–747, *Nov.* 4, *and pp.* 904–907, *Nov.* 25, 1929.

The absorption of tartaric acid and of sodium and potassium tartrates has been determined, a maximum absorption being found at about 2225 Å. At 3000 Å. the sodium salt is twice as absorbent as the potassium, while the latter is twice as absorbent as the acid. The density and extinction coefficient can be represented by Ketteler–Helmholtz formulæ with one constant $\lambda_0 = 2330$ Å. Beer's law does not hold and the absorption is attributed to the tartaric ion. The rotatory dispersion is calculated from a formula in which this value of λ_0 is used, and the results are compared with those of Lowry and Austin. Good agreement is found except near the absorption band. Little change is found in the other constants of the formula with change in concentration of the solution. F. S.

1409. Theory of Anisotropic Liquids. C. W. Oseen. *Arkiv f. Mat., Astron., och Fysik, Stockholm,* 20A. 25. [10 *pp.*], 1929.

This paper continues the general investigation [see Abstract 985 (1930)] of anistropic liquids and deals with the particular case of the reflection law for an obliquely truncated helicoidal distorted structure. For this purpose the optical waves in an opalescent cholesterin-nematic substance are mathematically discussed. H. H. Ho.

1410. Orientation of Anisotropic Liquids. V. Freedericksz and V. Zolina. *Am. Electrochem. Soc., Trans.* 55. *pp.* 85–95; *Disc.,* 95–96, 1929.

Forces arising in a thin layer of the surface of an anisotropic liquid, and to which the orientation of the drops in the form of a homogeneous layer is due, may be equilibrated by the effect of a magnetic field. This circumstance may permit quantitative as well as qualitative deductions as regards the character and the strength of these forces. Up to the present we succeeded in establishing first, that these forces do not depend on the kind of material on which the anisotropic liquid is placed; secondly, that they are not subject to great variations when the temperature conditions are changed, and, finally, that they decrease with the distance of the oriented drops from the surface of the liquid. The experiments and measurements have been completed with para-asoxyphenetol and anisaldazine. Both of these substances have given similar results. AUTHORS.

1411. Quantum Theory of Interference Fringes. E. Fermi. *Accad. Lincei, Atti,* 10. *pp.* 72–77, *July,* 1929.

On the basis of Dirac's theory the theory of an interference phenomenon is treated, that of Lippmann's fringes. The same method may be applied in general to the cases of similar interference phenomena. The result coincides with that of the classical electromagnetic theory. The fundamental method of Dirac consists in treating an atom that emits and absorbs light and the radiation in the region as a single system that has as coordinates besides the coordinates of the atom also certain other variables that serve to specify the values of the potentials of the electromagnetic field at every point of the region. J. J. S.

1412. Sulphide Colours on Metallic Copper. F. H. Constable. *Roy. Soc., Proc.* 125. *pp.* 630–635, *Nov.* 1, 1929.

The colours produced when a mixture of hydrogen sulphide and oxygen or air act on copper are confirmed as true interference colours by spectrophotometric observations of the reflected light from films of increasing thickness. The brightness of the silver colour of the first order is characteristic of these sulphide colours, and the reflecting power of this film is considerably greater than that of the original metallic surface. The presence of an invisible oxide film greatly reduces the rate of formation of the sulphide film. There appears to be no temperature coefficient of reaction velocity over the range 0° to 180°, but the velocity of sulphide formation is enhanced at 200°, and at 330° is very rapid, being six times faster than oxidation. C. O. B.

1413. Interferometer Measurements. J. T. Groosmuller and C. Lakeman. *Ann. d. Physik*, 3. 5. *pp.* 688–700, *Nov.* 28, 1929.

A simple theoretical solution of the problem of ultramicroscopic measurements made by the interferometer method. The possibility of utilising periodicity of illumination for the measurement of ultramicroscopic objects is discussed. The fact emerges that the image formed does not depend on the size of the object so much as upon its structure. It is therefore impossible in many cases where the structure is unknown to estimate the true size of an object. An investigation with the Michelson interferometer method yields conditions for measurement which are often independent of the structure, thus rendering measurement of the size possible. The results of a number of calculations and measurements with a double slit system are given. S. G. B.

1414. Experimental Verification of the Principle of Doppler-Fizeau for Light. P. Zeeman and M. Risco. *K. Akad. Amsterdam, Proc.* 32. 9. *pp.* 1141–1145, 1929.

The method used was akin to that of Fabry and Buisson, but certain improvements were introduced. The apparatus is described in detail and illustrated by a photograph, and the results obtained with mercury violet and green lines after suitable calculations have been applied are tabulated. J. G. H. B.

1415. Eikonal Vector Theorem and Fermat's Principle. L. Natanson. *Acad. Polonaise, Sci. et Lettres, Bull.* 8A. *pp.* 401–409, *Oct.*, 1929. *In English.*

The author introduces an auxiliary theorem in order to shorten and coordinate the calculations. If a curve S is regarded as representing a ray or path of propagation of light it is also assumed that S is orthogonal everywhere to surfaces of constant phase. A vector V localised in the tangent to the ray is said to represent the velocity of phase propagation if it satisfies the condition laid down in certain equations. A series of equations is evolved and a scalar function introduced and called by the name of Eikonal. The author's object in his discussion is to generalise the differential equation equivalent to Fermat's principle. When certain conditions are fulfilled the Eikonal vector theorem applies and the differential equation expressing Fermat's principle is true. T. C. H.

1416. Composition of the Han Mirror and its Reproduction. M. Chikashige. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 345–348, *Oct.*, 1929. *In English.*

An account of some experiments carried out which appear to confirm the statement made by the author that the Han mirror contains as its principal constituents 67 % Cu, 27 % Sn and 6 % Pb on an average. It is suggested that the Chinese added a large amount of lead to molten Spiegel metal in order to facilitate the casting and that 5 %–6 % of the head was retained after liquation. W. C. S. P.

1417. Deterioration of Silvered-Glass Mirrors and Reflecting Power of Polished Chromium Steel. R. K. Young and (Mrs.) V. Krotkov. *Roy. Astron. Soc., Canada, J.* 23. *pp.* 399–401, *Nov.*, 1929.

An account of some measurements made in order to correlate the change in appearance of a mirror with the reflecting power. The experiments were carried out on small silvered mirrors 3 in. × 3 in., but in no case did the authors obtain such a high reflecting power as given for silver on glass by the International Critical Tables and Langley. When, owing to ageing, the silver coat begins to look a little yellow, the reflecting power in the red and yellow part of the spectrum is not much impaired, but there is a big falling off in reflection at the violet part of the spectrum. A polished chromium steel mirror after eighteen months' use, still gives good results—particularly at wave-length $\lambda = 4000$; for small reflecting telescopes such mirrors are recommended. W. C. S. P.

1418. Optical Heterogeneity of a Fused Quartz Disc. L. W. Tilton and A. Q. Tool. *Bureau of Standards, J. of Research,* 3. *pp.* 619–628, *Nov.*, 1929.

In preparing a refractive index standard of fused quartz having the form of a 60° prism, it was considered advisable to investigate carefully the optical density of this glass, since appreciable variations might be present because of non-uniform heat treatment or other factors. With this in view the standard, together with nine small auxiliary prisms, was cut from a disc 52 mm. in diameter and 13 mm. thick. The indices of these prisms were measured, for five different wave-lengths, to an accuracy of a few units in the sixth decimal place. As a result, the standard is adjudged uniform within the limits of $\pm 4 \times 10^{-6}$ in its index of refraction. The optical heterogeneity distribution found within the whole disc is in accord with the hypothesis that the variations are caused mainly by temperature gradients which exist during the annealing or which change during the cooling procedure. AUTHORS.

1419. Instruments and Methods Used for Measuring Spectral Light Intensities by Photography. G. R. Harrison. *J.O.S.A. and R.S.I.* 19. *pp.* 267–316, *Nov.*, 1929.

1420. Bright-Ground Illumination in the Microscope. E. Spenke. *Ann. d. Physik,* 2. 5. *pp.* 537–554, *Aug.* 15, 1929.

In the theory of microscopic projection it is usual to calculate on the assumption of dark-ground illumination. Discrepancies are found between the results so obtained and those met with in practice, when bright-ground illumination is used, due to insufficient attention being paid to what is happening in the neighbourhood of the object. In the present paper a theory of microscopic projection using bright-ground illumination is set forth, taking as the simplest possible object a " dielectric point " on the axis of the microscope. [See Abstract 277 (1926).] A. C. M.

1421. Automatic Driving Apparatus for Telescopes. G. Alter. *Zeits. f. Instrumentenk.* 49. *pp.* 553–556, *Nov.*, 1929.

Small errors in the aligning of a telescope for astronomical photography introduce a perceptible picture distortion on the plate, whilst errors in the driving clock produce a line instead of a point image. The author describes a new type of setting and driving mechanism whereby these possible errors are eliminated. The pencil of rays from the star under observation normally falls on the apex of a four-sided reflecting pyramid. Should the rays move from the apex they are reflected into one of four photoelectric cells placed facing the four sides of the pyramid. The out-of-balance photoelectric current thus produced is then amplified and operates a relay. A very fine driving mechanism corrects the telescope and immediately ceases to function when the rays again fall on the apex of the pyramid.

R. C. F.

1422. Production of Monochromatic Light for Technical Purposes. F. Skaupy. *Zeits. f. techn. Physik,* 10. 12. *pp.* 627–629, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

In the beam emerging from the prism of the monochromator is placed a kind of macroscopic filter, which in one form consists of a large number of narrow parallel canals or tubes blackened on the inside, so that only light passing approximately parallel to their axes can make its way through the selector. In an improved form several blackened screens are employed, with a number of holes or slits in them, which are placed parallel to one another, with a certain distance between them, perpendicular to the light beam, the holes or slits being adjusted so that light can pass through successive ones, emerging as a number of narrow parallel beams of nearly monochromatic light. It is proposed to use a similar arrangement on the other side of the prism, so that the entering light may be made more nearly parallel. The instrument has no entrance slit. H. N. A.

1423. New High-Speed Kinematograph Camera. T. Suhara. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 334–337, *Oct.*, 1929. *In English.*

Describes the construction of a new high-speed camera which is capable of taking photographs at the rate of 40,000/sec. It consists of a circular drum approximately 140 cm. in diameter, so constructed that the film can be secured along its inner periphery, the length of film being about 4 m. This circular drum is directly driven at 40 r.p.s., and by means of toothed gearing from the same shaft a special revolving mirror is driven in the same direction. The speed ratio between them is such that the image on the film reflected by the revolving mirror has the same speed as the film. The revolving mirror of special stainless steel has the shape of a flat frustrum of an 180-sided regular polygonal pyramid, so that a rate of 40,500 photographs per sec. is obtained when the mirror is driven at a speed of 225 r.p.s. It is possible to obtain one thousand photographic impressions on the length of film. An adjustable slit is fixed to the camera wall so that it is between the film and the rotating mirror, thereby preventing the distortion and blurring of the image. In front of the camera lens a special automatic shutter is arranged to ensure that the film is exposed during one revolution only. Photographs of a sound wave produced by a strong electric spark between electrodes placed midway between the centre and a focus of an elliptic shell are given as an example of the performance of the camera. R. C. F.

1424. Askania Kinematograph-Theodolite. H. Fuss. *Zeits. f. Instrumentenk.* 49. *pp.* 529–540, *Nov.*, 1929.

The author describes a type of self-registering theodolite devised to give accurate information regarding the performance—speed, climb, turning—of different types of aircraft when in the air, efficiency of engines, and reliability of instruments carried on board. A kinematograph camera is mounted on an axis parallel to that of the Cassegrain telescope of the theodolite, and records on the film an image showing the object in the field of view of the telescope, the readings of the vertical and horizontal circles giving elevation and azimuth, and the hand of a watch to show the time. An observer manipulates the theodolite to keep the object in the centre of the field of view. A diagrammatic construction and photographic views of the whole and parts of the instrument are given. R. S. R.

1425. Comparison of Measurements of Distance by Optical Means with those of the Württemberg Official Land Survey. W. Schneider. *Zeits. f. Instrumentenk.* 49. *pp.* 541–550, *Nov.*, 1929.

The results obtained by three different optical means are tabulated and the errors compared with those in the official survey. With a Bosshardt-Zeiss tachometer an irregular error of 1/4000th of the distance arises, with the Kern–Aregger apparatus an error of 1/3000th, and with the Wild Universal theodolite an error of 1/1500th of the distance. The author concludes that the optical methods give an accuracy as good as that in the official method of surveying, while they are quicker and result in a 30–60 % decrease in cost. R. S. R.

1426. Imaging Space with Optical Instruments. W. Merté. *Zeits. f. techn. Physik,* 10. 12. *pp.* 624–627, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

An analytical investigation of astigmatism in connection with the imaging of portions of space can be carried out by means of a curve of the third degree. The full discussion of the question becomes possible, and as a result space can be imaged by means of narrow beams, using a rotationally symmetrical series of surfaces. H. N. A.

1427. Photographic Action of Low-Velocity Electrons. B. Rossi and G. Bernadini. *Accad. Lincei, Atti.* 10. *pp.* 182–185, *Aug.*, 1929.

After a brief discussion of previous results, and also the theoretical aspect of the problem, it is considered that by suitably varying the sensitisation of the plate photography of electrons with velocities below 25 volts should be possible. Commercial plates do not show any effects if the speed is below 40 volts, but Cole [see Abstract 678 (1927)] succeeded in photographing 22-volt electrons, using a plate " sensitised " with a thin film of fluorescent lubricating oil. The authors, using a similar method to Cole, but altering the plate and oil film, have obtained photographs of electrons with velocities as low as 17 volts, 75 seconds exposure, and by greatly increasing this exposure time, perceptible effects have been obtained with 16-volt electrons. The plates used were Cappelli ultra-sensitive plates, coated with a thin film of a very dense mineral oil, which possesses an intense green fluorescence. R. C. F.

1428. Law of Blackening of a Photographic Plate by Electronic Waves. W. Seitz and G. Harig. *Phys. Zeits.* 30. *pp.* 758–760, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag, Prague, Sept.*, 1929.

The blackening of a photographic plate by electronic waves has been studied over a wide range of electronic densities. At low densities the blackening is proportional to the logarithm of the product of the density and time of exposure. As the density is increased this simple relation is not obeyed; the amount of blackening is in excess of that calculated. It is suggested that the deviation from the simple relation is due to a secondary blackening caused by the X-rays formed in the plate by the incident electrons. F. J. W.

1429. Blackening of Photographic Layers used with Kathode-Ray Oscillographs. W. Rogowski, E. Flegler and P. Rosenlöcher. *Arch. f. Elektrot.* 23. *pp.* 149–152, *Nov.* 5, 1929.

Compares the blackening of photographic emulsions when produced by direct electronic impact of electrons with a velocity equal to 70,000 volts, and when produced by a fluorescent screen with the emulsion in direct contact with the other side of the glass plate supporting the screen. Records were obtained of oscillations of 200,000 cycles/sec., whilst the fluorescent screens were made of zinc sulphide and calcium tungstate respectively. It is found that electronic blackening gives very sharp and dense traces, whilst the traces get more diffuse as one increases the fluorescent screen supporting glass thickness. Further, the thickness of the fluorescent material affects the image, the sharpest image being obtained with a thick layer of zinc sulphide and with a medium layer of calcium tungstate. Finally, it is concluded that for photography with camera and lens system it is possible to obtain records of phenomena of the shortest duration, provided a sufficiently large electron discharge can be obtained. For very small electronic discharges and the duration period of about 10^{-6} sec. the direct electron blackening is the best. The film in contact with a fluorescent screen can be used with the shortest duration discharges and small electron discharges. R. C. F.

1430. Halogen Silver Photochemistry. Part VIII. Silver Value and Fixing Process. H. H. Schmidt and F. Pretschner. *Zeits. f. wiss. Phot.* 27. *pp.* 173–176, *Nov.*, 1929.

The chemical nature of the silver value of photographic emulsions can be partially elucidated if it is possible to obtain a fixing solution which does not dissolve silver in a fine state of division, and whose silver halide complex solution is stable and capable of being washed out from the gelatin. It should then be possible to explain the peculiarities of this silver value previously observed. Sodium sulphite is found to possess the above properties. It is shown experimentally that sodium sulphite does not dissolve silver, and, further, the silver value of silver chloride emulsions when fixed in a 10 % solution of sodium sulphite can be divided into two parts. 85 % of the silver value is dissolved by the fixing solution, and, therefore, cannot exist as atomic silver, but must exist either as an organic or inorganic silver compound. The remaining 15 % is not dissolved, and exists as metallic silver, or possibly silver sulphide. Finally, a correction is given in which Part V [see Abstract 3315 (1929)] should read Part VI, and Part VI [see Abstract 580 (1930)] should read Part VII. R. C. F.

1431. Latent Image. H. Leffmann. *Frank. Inst., J.* 208. *pp.* 661–663, *Nov.*, 1929.

Criticises the methods adopted by recent investigators, in that the field examined has been much too narrow. No one has considered the nature of the latent image in the light of the fact that it can be made visible by development after fixation when apparently there is no halide left. Collodion, as well as dry, plates show this phenomenon. Further, Nipher has shown that after prolonged over-exposure of a plate, development in the dark room produces fog, whereas if developed in the light perfect positives can be obtained. Emanations from some of the more volatile metals, such as Al, Zn, Hg, Mg, produce effects on dry plates which can be brought out by normal development or by development after fixation. Theories generally advocated concerning the nature of the latent image do not appear to explain these peculiarities. R. C. F.

1432. Optical Sensitisation of Silver Halogen Emulsions. Part I. Adsorption of Orthochrome T by Silver Bromide. S. E. Sheppard and H. Crouch. *Zeits. f. wiss. Phot.* 27. *pp.* 180–192, *Nov.*, 1929.

The distribution of isocyanine-orthochrome-T-bromide between water and chloroform was studied as a means of estimating the probable amount of dye that would be adsorbed by the halogen salt of silver. The effects of the addition of halogen salts on the distribution was also studied. It was shown that when the dye is treated with an acid, an equilibrium mixture of coloured and colourless form of the dye is produced, and that the proportions depend on the *p*H concentration. As the amount of the colourless form increased, the absorption of the ultra-violet rays increased. The optical sensitisation was shown to depend upon the decomposition of the colouring matter. F. J. B.

1433. Desensitising Action of Sodium Sulphite, and Addition of Desensitisers to Developers. Frances M. Hamer. *Phot. J.* 69. *pp.* 479–480, *Nov.*, 1929.

Many desensitisers prove valueless when examined for their power of preventing fog during white light development, owing to the destruction of the desensitisation, which has been produced by the preliminary bath, by the sulphite or carbonate in the developer. From an examination of the desensitising action of a 1 in 5000 solution containing sulphite or carbonate in the proportions that they occur in the developer, it is found that numerous desensitisers lose their efficacy with the addition of these compounds to the solution. Safranine and pinakryptol green, however, have a stronger desensitising action with this addition, and this can be accounted for by the fact that the 3·3 % to 15 % solutions of sodium sulphite examined cause definite desensitisation. These values for the sodium sulphite are the proportions in which it usually occurs in developers. Certain authors have stated that the addition of the desensitiser to the developer produces a more powerful action, but in the light of the above this is shown to be incorrect. The statement that a 1 in 25,000 solution of safranine or pinakryptol green when added to the developer is better than a 1 in 5000 solution used as a preliminary bath is experimentally examined. The results show that this cannot be true, and this divergence can only be attributed to the different methods of testing used. The amount of desensitiser which can be added to the developer is limited by the tendency of the latter to precipitate the desensitiser, but no such difficulty can be encountered when the desensitiser is used as a preliminary bath. R. C. F.

1434. Measurements with the König-Marten Spectrophotometer. K. Schaum, L. Hock and W. Dannefelser. *Zeits. f. wiss. Phot.* 27. *pp.* 145–168, *Nov.*, 1929.

Describes a means of standardising the König-Marten spectrophotometer whereby the number of angles to be read is considerably reduced, thereby greatly simplifying the examination of varying systems. By means of this new method the action of sodium hydroxide on sodium picrate was investigated. Initially it is found to play a part which can be made reversible by neutralisation, but afterwards, particularly in light, a far-reaching action occurs with the formation of ammonia. R. C. F.

1435. Effect of Temperature upon Fluorescence of Organic Solutions. J. R. Jenness. *Phys. Rev.* 34. *pp.* 1275–1285, *Nov.* 1, 1929.

Examines spectrographically the effect of temperature upon the fluorescence of alcoholic solutions of rhodamine B, eosin, tetrachlorofluorescein and sulfonefluorescein, whilst fluorescein has been studied by means of a spectrometer. The temperature shift of the peak, when observed, is proportional to the temperature change, whilst all shifts are in the same direction as those observed for absorption, as are shifts produced by varying the concentration. The shift due to concentration is proportional to the logarithm of the concentration. The fluorescence is a maximum at room temperature for eosin and fluorescein, whilst a decrease in temperature causes a shift to shorter waves of the fluorescence peaks. For fluorescein an increase in temperature causes a widening of both the fluorescence and absorption bands, with the widening greater on the red side of the band. A decrease in temperature or an increase in concentration of rhodamine B causes the peaks of the bands to shift towards the longer wave-lengths, whilst a decrease in concentration causes a widening of the fluorescence band, but a narrowing of the absorption bands. Tetrachlorofluorescein shows only slight shifts, whilst a lowering of temperature causes the appearance and growth of a new band on the red side of the main band. Sulfonefluorescein shows no appreciable shift as the temperature is lowered, but the shorter wave bands become more prominent. R. C. F.

1436. Fluorescence Spectra of Vapours of Fluorobenzene and *p*-Fluorotoluene. Mary W. Monypenny and A. Russell. *Chem. Soc., J. pp.* 2436–2438, *Nov.*, 1929.

Under the influence of ultra-violet light fluorobenzene and *p*-fluorotoluene emit well-banded spectra in the ultra-violet, identical with their Tesla-luminescence spectra, but containing fewer bands. No part of the fluorescence spectrum can, however, be identified with the bands in the green region found in the Tesla spectrum. A. J. M.

1437. Tesla-Luminescence Spectra of Some Halogen-Substituted Derivatives of Benzene. A. Russell and A. W. Stewart. *Chem. Soc., J. pp.* 2432–2436, *Nov.*, 1929.

On excitation by the high-tension discharge from a Tesla transformer chlorobenzene gives a feeble emission consisting of twelve sharp narrow bands between λ2955 and λ2745. Fluorobenzene gives a much more complete spectrum, but no light emission is observed with bromobenzene and iodobenzene. Spectra in the green and ultra-violet region are given by *o*- and *p*-dichlorobenzene, but *m*-dichlorobenzene only gives a feeble emission in the green. The three chlorotoluenes and *p*-fluorotoluene give ultra-violet spectra and very intense spectra in the green region. The presence of a halogen atom in the ring has only a weakening effect on the spectra of the parent substance. A simple wave-number relationship holds between the bands, the series of bands, for any one compound, being divisible into groups, the members of which exhibit a constant difference from their congeners in other groups. The green spectrum, when it is obtained, is merely the projection of the ultra-violet spectrum through a definite interval. A. J. M.

1438. Methods of Filter Radiometry. D. C. Stockbarger and L. Burns. *Phys. Rev.* 34. *pp.* 1263–1270, *Nov.* 1, 1929.

The principal error in filter radiometry is analysed and shown to be due to interpretation of results rather than to the sloping transmission characteristics of the radiation filters which make the boundaries of the spectral regions appear to be indefinite. It is shown that if the filter cut-off is assumed to be at the point where the transmission of the filter becomes zero, as is done in many instances, the observed radiant power of the spectral band so defined is in error, but that the error can be made to disappear by assuming the cut-off to be at a different wave-length. This effective cut-off of a filter is located at such a wave-length that the energy transmitted by the filter below is equal to that which is selectively absorbed by it above the cut-off. In effect the transmission curve of the filter is thus changed to one of rectangular shape so that it cuts off sharply at the effective wave-length. Two simple analyses of water-filtered quartz mercury-arc radiation were made with the aid of two glass filters. The zero cut-off of the first coincided with the effective cut-off of the second, so that a comparison could be made between the two interpretations. A very considerable difference was found between the results when the usual approximate correction factor was applied to the first result, but by substituting the exact factor, computed from line intensity measurements the results of the two analyses were made to agree within about 0·5 %. This indicated the usefulness of the effective cut-off method in making accurate radiation measurements. AUTHORS.

1439. Theory of Quanta. P. Fadda. *Pont. Accad. Sci., N. Lincei, Mem.* 12. *pp.* 57–197, 1929.

Gives a *résumé* of the quantum theory with no attempt or claim to extend it. Chapter I is largely historical, and traces the evolution of radiation theory, up to the point where Wien's law was put forward. Chapter II introduces the quantum hypothesis of Planck, and the proofs of Poincaré and Jeans that no other hypothesis can explain the black-body spectrum. In Chapter III the photoelectric effect is considered, together with Einstein's light-dart form of the theory, and fluorescence and the Compton effect are discussed. Specific heat theory, as given by Einstein and by Debye, is the subject of Chapter IV, which refers in passing to the work of Born and Karmann, and gives the relation of quantum theory to Nernst's Heat Theorem. The next two Chapters deal with atomic theory —Bohr's atom, spectral lines, Moseley's law, ionisation potentials, adiabatic invariants, the second quantum number for elliptic orbits, the relativity correction and Sommerfeld's form of the quantum conditions for quasi-periodic motions. Chapter VII deals at greater length with the general basis of the theory and introduces the correspondence principle, whilst Chapter VIII gives a brief account of the new mechanics in the forms given to it by Dirac and by de Broglie and Schrödinger respectively. J. H. A.

1440. Absorption Spectra of Cinnamic and Hydrocinnamic Acids. L. Marchlewski and O. Wyrobek. *Acad. Polonaise, Sci. et Lettres, Bull.* 7A. *pp.* 331–334, *July*, 1929. *In English.*

The spectra were examined in alcoholic and aqueous solutions respectively. Details of observed values are given. F. S.

1441. Absorption Spectra of Xylenes. (Miss) B. Charlampowiczówna and L. Marchlewski. *Acad. Polonaise, Sci. et Lettres, Bull.* 7A. *pp.* 335–339, *July*, 1929.

Details of the absorption of ortho-, meta- and para-xylenes are given, that of para-xylene being more intense than for the other isomers. F. S.

1442. Absorption Spectrum of Carbon Disulphide. F. A. Jenkins. *Astrophys. J.* 70. *pp.* 191–193, *Oct.*, 1929.

Some photographs of the absorption of CS_2 vapour were made with a 21-ft. grating and a microphotogram is reproduced. The resemblance to the band spectrum of a diatomic molecule is remarked. A number of frequency differences between 250 and 280 $cm.^{-1}$ has been noted. F. S.

1443. Absorption Spectra and Chemical Linkage of Thallium Halides in the Gaseous State. K. Butkow. *Zeits. f. Physik*, 58. 3–4. *pp.* 232–249, 1929.

From measurements of the absorption spectra of TlCl, TlBr, and TlI vapours in the region 7000 to 1900 Å., energy level systems are derived for TlCl and TlBr on the basis of which the convergence positions and heats of dissociation are determined (heat of dissociation for TlCl = 87·0 k.cal./Mol., for BrCl = 73·5 k.cal./Mol. It is shown that all three compounds investigated are, in the vapour state, atom compounds (*i.e.*, not ion compounds. W. S. S.

1444. Absorption Spectra of Alkali Halide Phosphors containing an Addition of Thallium. Magdalene Forró. *Zeits. f. Physik*, 58. 9–10. *pp.* 613–618, 1929.

The absorption spectra of a further six alkali halide phosphors have been measured and compared with those studied earlier [see Abstracts 3579 (1929) and 162 (1930)]. With the exception of the cæsium iodide phosphor, they all give similar spectra. It is, however, possible to observe slight differences due to the various anions. The absorption spectrum of pure caesium iodide has also been measured. F. J. W.

1445. Absorption Spectrum of Cobalt Chloride, $CoCl_2$. P. Vaillant. *Comptes Rendus*, 189. *pp.* 747–749, *Nov.* 4, 1929.

The following solutions were examined by means of a spectro-photometer provided with a photoelectric cell—aqueous solutions of concentration *n*, *n*/2, and *n*/10, and solutions in ethyl alcohol, NaCl and $ZnCl_2$ solutions. Comparison of results leads to the conclusion that the absorbing agent is the Co^{++} ion. F. S.

1446. Absorption Spectrum of Nitrogen Pentoxide and its Method of Decomposition. H. C. Urey, L. H. Dawsey and F. O. Rice. *Am. Chem. Soc., J.* 51. *pp.* 3190–3194, *Nov.*, 1929.

The absorption spectrum of nitrogen pentoxide was measured, and it was shown to be continuous from 3050 Å., and extended to the far ultraviolet. The long wave-length limit of this continuous spectrum corresponded very closely to the energy change in the reaction $N_2O_5 = 2NO + O$, and indicates that this may be the primary photochemical reaction. The mechanism of the thermal decomposition was discussed and two possible mechanisms for the reaction were suggested. F. J. B.

1447. Absorption Spectra and Stability of Isomers. (Mme.) Ramart-Lucas. *Comptes Rendus*, 189. *pp.* 802–804, *Nov.* 12, 1929.

The ultra-violet absorption spectra were determined for the diaryl derivatives of ethane and ethylene. The results showed that the determination of the structure of isomers of the series under consideration was more readily obtained from the ultra-violet absorption spectra than by any other physical property. F. J. B.

1448. Ultra-Violet Absorption Spectra of Dibasic Fatty Acids. (Mme.) Ramart-Lucas and F. Salmon-Legagneur. *Comptes Rendus*, 189. *pp.* 915–917, *Nov.* 25, 1929.

The ultra-violet absorption spectra of dibasic fatty acids were determined for acids containing C_2 up to C_{18}. The absorption spectra were determined in 95 % alcohol at a concentration of 1/10 mol. per litre. Curves of the relationship between the frequency and the absorption coefficients show a displacement towards the ultra-violet when the series passed from oxalic to succinic acid, and towards the visible from C_2 to C_{10}. F. J. B.

1449. Absorption of Ozone in the Infra-Red Region of the Solar Spectrum. F. Lindholm. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 53–56, 1929.

Results were obtained at Davos in the early part of 1929 showing clearly absorption by ozone at $4\cdot8\ \mu$, and assuming a layer of ozone 3 mm. thick the absorption coefficient is $0\cdot15$, a value much greater than that for Chappuis' bands. Observations are used to eliminate the effect of water vapour, and by using together the results for days with the same amount of water vapour the variation remaining is attributed to ozone changes. With a more sensitive instrument it is hoped to observe absorption for the band between 9 and 10 μ. R. S. R.

1450. Rotation - Vibration Spectrum of Ammonia. R. M. Badger and R. Mecke. *Zeits. f. phys. Chem.* 5. *Abt. B.* 5. *pp.* 333–354, *Oct.*, 1929.

The rotation-vibration spectrum of ammonia has been photographed in the region 10,000 Å. → 6900 Å., with an instrument having a dispersion of $2\cdot6$ Å. per mm. Three absorption bands were recorded, 8810, 7920 and 6450 Å., and they were analysed. The data thus obtained were used to clear up the entire absorption spectrum of ammonia. The three molecular fundamental frequencies are $\nu_1 = 3396 - 60n$, $\nu_2 = 1630$, $\nu_3 = 966$. The first is attributed to the N-H bond. The two moments of inertia of the pyramidal molecule are $2\cdot79 \times 10^{-40}$ and $3\cdot40 \times 10^{-40}$. The pyramidal distances are $N \rightarrow H\ \ 0\cdot977 \times 10^{-8}$, $H \rightarrow H\ \ 1\cdot43 \times 10^{-8}$. Height, $0\cdot517 \times 10^{-8}$ cm. A. C. M.

1451. Spectrographic Investigation of the Corona Effect. S. P. Zebrowski. *Phys. Zeits.* 30. *pp.* 687–692, *Oct.* 15, 1929.

For the corona effect round a fine wire in air the spectrograms showed seven principal groups of lines, of which one only, and that a weak group, lay in the visible, the remaining six groups being in the ultra-violet. Almost all the lines observed correspond to lines in the spark spectrum of air, although the intensity distribution through the spectrum is very different. With neon substituted for air, the corona spectrum again consisted of groups having, however, pronounced band characteristics. Determinations of the energy distribution along the corona spectra were made by calibrating the photographic film blackening in terms of the blackening produced by the light from the crater of the carbon arc, which is known to have a black body energy distribution corresponding to $T = 3700°$ Å. The results show that the energy of the visible region equals only 16·7 % of the total optical energy for the corona spectrum in air. In neon the proportion is 23·6 %. W. S. S.

1452. Theory of Complex Spectra. J. C. Slater. *Phys. Rev.* 34. *pp.* 1293–1322, *Nov.* 15, 1929.

Atomic multiplets are treated by wave mechanics, without using group theory. Hund's scheme for multiplet classification is derived directly from theory. Energy distances between multiplets are computed and compared with experiment in some typical examples. There is no treatment of the separations between the various terms of a multiplet, since that has been done elsewhere, but only between one multiplet and another. It is found that Hund's rule, that terms of large L and S values lie lowest, has no general significance; the present theory leads to the same results as the rule when it is obeyed experimentally, but many cases which were exceptions to that rule are in agreement with the theory. The method of calculation of multiplet distances is described in sufficient detail, with the necessary tables of coefficients, etc., so that further checks with experiment could easily be made. AUTHOR.

1453. Vacuum Spark Spectra in the Extreme Ultra-Violet. B. Edlén and A. Ericson. *Nature*, 124. *pp.* 688–689, *Nov.* 2, 1929.

A concave grating with 571 lines per mm. was mounted in vacuum to give dispersions of 3·5 Å. per mm. at 100 Å., and 6·5 Å. per mm. at 1000 Å. One hundred and forty lines of Cu have been measured between 200 Å. and 126 Å. The spectra of Li II and Be III have also been measured down to 100 Å. The respective ionisation potentials are found to be 75·282 and 153·10 volts respectively. F. S.

1454. New Method for Study of Voltage-Intensity Relations and Application to the Mercury 2537 Å. Line. F. C. Ostensen. *Phys. Rev.* 34. *pp.* 1352–1356, *Nov.* 15, 1929.

All previous measurements of the relation between the intensity of spectrum lines and the velocity of the exciting electrons have been subject to uncertainties due to the presence of secondary electrons. To eliminate these effects a beam of electrons is so concentrated by a magnetic field as to prevent their striking any metal surfaces until they reach a collector which traps all secondaries. This arrangement insures that the light emitted from the path of such a beam is produced solely by electrons which have a specified velocity (to within the Maxwellian distribution). The above method was applied to a study of the variation with electron velocity of the intensity of λ2537 in the Hg spectrum. The results obtained agree in a general way with those of other investigators. A maximum intensity is found at about 6·0 volts, which agrees within 0·2 volt of the values given by White and Hanle. The rate at which the intensity drops off beyond the maximum is, however, considerably greater than that given by previous workers. This may be attributed to the elimination, in the present work, of secondary electrons. AUTHOR.

1455. Life and Concentration of Metastable Atoms and Quenching of Mercury Resonance Radiation. E. Gaviola. *Phys. Rev.* **34.** *pp.* **1373–1384,** *Nov.* **15, 1929.**

A complete and general study of the dependence of life and concentration of metastable mercury atoms, optically excited, on experimental conditions, of foreign gas-pressures, and on intensity of illumination is given. This study explains why the life cannot be larger than 10^{-2} sec. under laboratory conditions and why foreign gases act so differently in regard to the accumulation of excited atoms. The theoretical results are in good agreement with all experimental data available. An improved and more general formula for the quenching of mercury resonance radiation is obtained. The efficiencies of collisions of the second kind of metastable mercury atoms with N_2, A, and He molecules are calculated numerically. It is shown that the concentration of metastable atoms increases only with the square root of the intensity of the exciting light and not with the exciting light itself as generally assumed. AUTHOR.

1456. Flame Spectra of Potassium, Magnesium and Copper. H. Lundegårdh. *Arkiv. f. Kem. Min. och Geologie, Stockholm,* **10. 1A.** **[26 pp.], 1929.** *In English.*

The sprayer for introducing salt solutions into the flame and the special burner are described. Timed exposures with an electromagnetic shutter were made with a quartz spectrograph, and the resulting spectrograms investigated with a thermoelectric photometer. The application of the results to quantitative spectrum analysis are discussed. It is estimated that the amounts of substance used to produce a record are 0·36, 0·20 and 0·10 mg. for K, Mg and Cu respectively, while the theoretical amounts to give a spectrum are 0·004, 0·002 and 0·001 mg. respectively. The accuracy of analysis varies from 4·06 % to 6·51 %, and the influence of foreign substances is considered. F. S.

1457. First Spectrum of Xenon. W. F. Meggers, T. L. de Bruin and C. J. Humphreys. *Bureau of Standards, J. of Research,* **3.** *pp.* **731–763,** *Nov.,* **1929.**

Discharge tubes filled with xenon are operated so that only neutral atoms are emitting. Wave-lengths are determined for 318 lines, from 3442·77 to 10,107·2 Å., and these are tabulated together with their relative intensities and the combinations of terms giving rise to them. Practically all of the lines are accounted for by these terms. As a result it appears that the normal state of the neutral xenon atom (s^2p^6) is represented by a single level ($^1S_0$), and successive excited states arise from the addition of *s*–, *p*–, *d*–, *f*– electrons to the xenon ion (s^2p^5). One of the series identified was unique in the regularity of its effective quantum numbers. (There is an analogous series in the spectrum of each of the homologous elements Ne, A and Kr.) This series was consequently used to determine the absolute values of the terms. It leads to a value 97,835 for the largest

term, which means an ionisation potential of 12·078 volts for neutral xenon. Photographs give a map of the spectrum from 3400 to 10,100 Å.
A. C. M.

1458. Spectra of Helium (He_2) and Hydrogen (H_2). W. Weizel. *Zeits. f. Physik*, 56. 11–12. *pp.* 727–739, 1929.

The band spectra of the lighter molecules are characterised by the fact that when the rotation is small they may be classified as type *a* (Hund's classification), and when the rotation is large as type *d*. The spin is fully coupled, and the *l*-coupling is very tight. Spin multiplet-structure is not present, and intercombinations between term-systems of different multiplicity are rare. The spectra of He_2 and H_2 are criticised from this point of view. In He_2 a term 3^3u has been found, belonging to a series hitherto undiscovered. In H_2 the explanation of the triplet terms due to Finkelnburg and Mecke is rejected, and the *l*-coupling, in the case of complete coupling, is investigated. Terms with the same value of ρ (the rotation-component of *l*) are equal in the case of complete coupling, independent of the sign of ρ. The rotation cannot be explained in terms of a homogeneous magnetic field perpendicular to the molecular axis, but in terms of the field of a magnetic quadripole. Terms connected with a $p\sigma$-, $d\sigma$- or $d\pi$-valence electron are characterised by deep energy-levels, great internuclear distances and small vibration quanta. The relative weakness of the Lyman bands in H_2 compared with the Werner bands can be explained by the properties of the initial and final terms concerned. This entails an argument against the Lyman bands being due to a singlet-singlet combination. A. C. M.

1459. Excitation of the Spectrum of Helium. L. S. Ornstein. *Frank. Inst., J.* 208. *pp.* 589–594, *Nov.*, 1929.

Contains an account of work done by Burger and the author on the emission of light by helium with electronic excitation. The first problem investigated was that of the equilibrium of the 2^3P and of the 2^1P levels. The $2^3S - 2^3P$ and $2^1S - 2^1P$ lines originate from these levels, and the lines of the $2^3P - m^3S$ and $2^3P - m^3D$ series (sharp and diffuse series) bring other atoms to the 2^3P state, and analogously in the singlet system. The number of jumps to and from 2^3P and 2^1P levels were measured as a function of the pressure, and it was found that even at the lowest pressure employed the atoms coming down to the P levels are a small fraction of those starting from those levels so that the excitation of the P levels takes place chiefly from the lower states. The same sort of thing holds for the D-line emission of sodium. The change of azimuthal quantum number by electronic impact shows a striking analogy with the effect of radiation. The excitation of helium was also studied, using electrons of known different velocities at different pressures, and interesting results are found. H. N. A.

1460. New Terms in the Oxygen Arc Spectrum. R. Frerichs. *Phys. Rev.* 34. *pp.* 1239–1246, *Nov.* 1, 1929.

Methods have been developed for the powerful excitation of the oxygen arc spectrum in the absence of bands, in large diameter heavy current discharge tubes and in narrow capillary quartz discharge tubes. In both tubes the green auroral line appears strongly. The oxygen arc spectrum has been photographed with these discharge tubes with large dispersion, and many new lines have been observed. Fifty new lines have been classified in the oxygen arc spectrum involving six new triplet terms and one new singlet term based on the $2s^2 2p^3 (^2D)$ and $2s^2 2p^3 (^2P)$ configurations of the ion. AUTHOR.

1461. Spectrum of Oxygen under Different Conditions of Excitation. D. B. Deodhar and S. K. Dutt. *Phil. Mag.* 8. *pp.* 617–625, *Nov.*, 1929.

The authors have studied the spectrum of oxygen at a pressure of 0·2 to 0·3 mm. in a Geissler tube and in a special type of quartz discharge tube. The kathode of this special tube was made of a platinum strip 10 mm. long and 1·5 mm. wide, the middle portion of which was coated with barium oxide, which served as a strong source of electrons when electrically heated. The internal volume of the anode, being enclosed by an equipotential surface, gave a discharge which may conveniently be called a "field-free" discharge. Striking differences are observed and tabulated in the nature of the two spectra, and in addition a new band-head is observed in the region of λ4500. The structure of this band is being investigated with the help of a Hilger interchangeable quartz spectroscope of 10-ft. focus. T. B.

1462. Arc Spectrum of Arsenic. W. F. Meggers and T. L. de Bruin. *Bureau of Standards, J. of Research*, 3. *pp.* 765–781, *Nov.*, 1929.

Metallic arsenic was vaporised in graphite or copper arcs, and the line emission spectrum was investigated throughout the entire range accessible to photography with concave grating and with quartz prism spectographs. The measured wave-lengths range from 1889·85 to 10,023·98 Å. The spectrum is relatively simple but difficult to analyse because many important lines lie either in the far ultra-violet or in the infra-red. The new data (vacuum wave numbers, estimated relative intensities, and self-reversal of certain lines) have made possible a fairly complete analysis of the AsI spectrum. Forty-two levels have been identified; they include practically all of the spectral terms arising from the addition of a $4p$, $5s$ and $4d$ electron to the s^2p^2 configuration of the As$^+$ ion. The normal state is represented by a $^4S_2$ term for which the absolute value is estimated to be 80,692·72, corresponding to an ionisation potential of about 10 volts. Combinations of the identified terms account for 100 observed AsI lines, ranging in wavelength from 1574·7 to 10,614·0 Å., our observations being supplemented by two infra-red lines detected radiometrically by Randall and nineteen lines in the Schumann region obtained with a fluorite spectrograph in *vacuo* by L. and E. Bloch. AUTHORS.

1463. Transition-Probabilities in Lithium Atoms. B. Trumpy. *Zeits. f. Physik*, 57. 11–12. *pp.* 787–796, 1929.

The purpose of this paper was to verify Hargreaves' theoretical estimation of the intensities of the lithium lines [see Abstract 1456 (1929)]. According to this estimation, the third member of the principal series should be stronger than the second. The intensity ratio of the lines 3233 Å. and 2741 Å. was measured photometrically in absorption, the lithium vapour being contained in a steel tube, in an argon atmosphere, with a magnesium spark to provide the continuous source. It was found that the second line is stronger than the third. To trace the discrepancy, the intensities to be expected are recalculated, and it is shown that Hartree's method of calculation gives good eigen-values, but that the dependence of the intensities of higher lines on the eigen-values is so critical that the accuracy of the method is insufficient for the purpose. The experimental results show that f_n/f_{n+1} passes through a minimum when n (the series number) is 2. A. C. M.

1464. Calculation of Number of Dispersion-Centres in Sodium. W. K. Prokofjew. *Zeits. f. Physik*, 58. 3–4. *pp.* 255–267, 1929.

Sugiura's calculation of the first two doublets in the principal series of sodium is simplified by using Störmer's method for the calculation of the eigen-values used in the Schrödinger equation. The results are extended to the third and fourth doublets of the principal series, and to some of the doublets of the subordinate and combination series. A. C. M.

1465. Intensity-Ratios in the Principal Series of Cæsium. C. Füchtbauer and H. W. Wolff. *Ann. d. Physik*, 3. 3. *pp.* 359–372, *Oct.* 30, 1929.

The measurement of the intensity-ratios of the components of the doublets which constitute the principal series of cæsium is made, using the emission from a high-vacuum tube containing cæsium. Previous measurements had been made in absorption [see Abstract 1420 (1927)]. The second member of the series showed a slight decrease in the intensity-ratio as the pressure of the vapour increased due to self-absorption, which affected more greatly the intenser component. The extrapolated value was 1 : 3·3. The third member of the series gave the value 1 : 4·6. A. C. M.

1466. Raman Spectra of Calcite, Aragonite and Potassium Carbonate. M. Kimura and Y. Uchida. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 203. *pp.* 199–204, *Aug.* 26, 1929. *In English.*

The intensities of the infra-red absorption frequencies of calcite do not parallel those of the corresponding Raman lines. This matter is here re-investigated, observing the intensities of the lines when the optic axis of the crystal has different orientations with regard to the directions of the incident and scattered beams. The Raman line corresponding to the optically inactive frequency is always the strongest line. The line corresponding to the infra-red wave-length 11·4 μ appeared more strongly when the incident light-beam was perpendicular to the optic axis than when it was parallel to the optic axis. In aragonite, and in an aqueous solution of potassium carbonate, the lines corresponding to the optically inactive frequency were strong. In addition, traces of other lines were found in aragonite. A. C. M.

1467. Excitation of the Raman Effect. R. W. Wood. *Frank. Inst., J.* 208. *pp.* 617–626, *Nov.*, 1929.

In order to avoid uncertainty as to the exciting line when using mercury light, the use of a special helium tube is recommended. This tube is about 10 ft. long, wound into a spiral about 2½ in. diameter and operated with 20,000 volts and 25 m.A. Through the spiral is placed a tube of glass which passes only λ3888, and through the latter the Raman tube itself. Spectrograms can then be enlarged and lines read directly with a wave-length scale. A vertical tube is also described for use with the mercury light, and also the use of an aluminium reflecting cylinder. In the case of HCl gas, the only line observed corresponds to the head of the Q branch. F. S.

1468. Theory of Raman Effect. G. Placzek. *Zeits. f. Physik*, 58. 9–10. *pp.* 585–594, 1929.

The quantum mechanics of the Raman scattering, if it is regarded as an absorption of a quantum $h\nu$ followed by an emission of a quantum $h\nu'$, is shown to lead to results contrary to experiment. Further, the processes which give rise respectively to the Stokes and anti-Stokes Raman lines cannot be regarded as compensating ones as far as the thermal equilibrium of the scatterer is concerned. Hence it follows that the intensity ratio of these lines depends not only on the number of molecules in the initial and final states, but also on the frequency of the exciting radiation and on the proper frequency of the molecules themselves. Quantitative formulæ for the intensity ratio are given. G. C. McV.

1469. Theory of Smekal-Raman Effect in Hydrogen-Like Atoms. B. Podolsky and V. Rojansky. *Phys. Rev.* 34. *pp.* 1367–1372, *Nov.* 15, 1929.

It has been shown by Schrödinger [see Abstract 55 (1927)] and O. Klein [see Abstract 1650 (1927)] that the Kramers–Heisenberg formulæ for dispersion and incoherent scattering can both be obtained by an extension of Schrödinger's method for treating dispersion, the terms in the Hamiltonian involving squares of the potentials being neglected. The resulting formulæ agree with those of Dirac. They are, however, inconvenient for calculations, as they contain summations with respect to all energy levels combining with the pair of levels under consideration, and thus imply complicated integrations when a continuous spectrum is present. This paper treats the problem of a hydrogen-like atom, acted on by light the wave-length of which is large compared to the size of the atom and the frequency of which is not too near a resonance frequency, and develops a method which obviates the necessity of integrating over the continuous range. It is an extension of the method used by one of us in treating the dispersion by atomic hydrogen. It is applied in detail to the first two levels of H. Formulæ are derived for the intensities of the Smekal–Raman lines with a shift corresponding to the first absorption line. AUTHORS.

1470. Classification of Spectral Lines of Chlorine, Bromine and Iodine. K. Asagoe. *Kyoto Coll. Sci., Mem.* 12. *pp.* 275–326, *Nov.*, 1929. *In English.*

The spectral lines of chlorine, bromine and iodine were first classified into arc and spark types by observing (1) the effect of constriction of a part of a Geissler tube upon the intensities of the lines, (2) the change of relative intensities called forth by putting a capacity in the circuit, and (3) the effect of insertion of a self-induction in the condensed heavy discharge circuit. Then the spark lines were further sorted out into spark, super-spark lines, etc., by investigating the exciting stages. The various excitation conditions were obtained by (1) varying the intensity of a magnetic field applied to the Geissler tube, and (2) capacity and (3) self-induction placed in the circuit. Thus, all the spectral lines of these elements lying in the region covering visible and ultra-violet (up to 2000 Å.) were classified. Arc lines are found only in the visible region, while spark lines are distributed all over the entire region investigated. Super- and super-super-spark lines lie generally in the more refrangible side. AUTHOR.

1471. Stark Effect for Chlorine, Bromine and Iodine. K. Asagoe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 206. *pp.* 243–250, *Sept.* 20, 1929. *In English.*

Large shifts were reported [see Abstract 689 (1927)] towards the red of spectral lines of chlorine, bromine and iodine when the vapour pressure

and current density were both increased. These were explained as a Stark effect due to ions. In the present paper experiments are described intended to obtain direct evidence of the Stark effect. All the lines in the region examined (5000 Å. → 3900 Å.) for all three elements suffered shifts to the red in the Stark effect, save an iodine line at 4235 Å. and a bromine line at 4203 Å., which were displaced towards the violet. The magnitude of the shifts was several tenths of an Ångström unit at the field of 150 kV per cm., but several lines had a larger shift. These are thought to be due to transitions from higher quantum orbits. The wave-length shifts seem to be nearly proportional to the square of the field intensity. No measurable displacements were observed for spark lines. Some lines, however, were slightly broadened towards the red. It is noted that an aluminium hydride band is strongly emitted in an iodine tube with a trace of hydrogen present and more strongly the less the added hydrogen. Some rotational lines of this band seemed to be slightly affected by the electric field.
A. C. M.

1472. Second-Order Zeeman Effect. E. Guth. ***Zeits. f. Physik,*** **58. 5–6. *pp.* 368–372, 1929.**

A wave-mechanics approximation formula gives $\Delta\lambda = -0\cdot066$ Å. as the maximum increase in the Zeeman separation due to the second-order effect, and an upper limit $\Delta\lambda = -0\cdot078$ Å. for the case of the 13th Balmer line in a magnetic field of 30,000 gauss. The effect is noticeable only for high values of the principal quantum number, and so is unsuitable for distinguishing between the old and the new quantum theory. For, the upper limit calculated in terms of the old theory is 0·0777 Å., indistinguishable from the upper limit calculated by wave mechanics and quoted above.
A. C. M.

1473. Magnetic Analysis of a Spectrum by Means of Unresolved Zeeman Patterns, and its Application to AgII. A. G. Shenstone and H. A. Blair. ***Phil. Mag.*** **8. *pp.* 765–771, *Nov.*, 1929.**

A method of determining the Landé *g*-values from unresolved Zeeman patterns is discussed. The method is applied to the spectrum of AgII, and the cases where the measured values disagree with the theoretical are considered with regard to the usefulness of *g*-values as compared with intensities as criteria in the indentification of terms.
AUTHORS.

1474. Theory of Normal Zeeman Effect. O. Halpern and T. Sexl. ***Ann. d. Physik,*** **3. 5. *pp.* 565–574, *Nov.* 23, 1929.**

A mathematical investigation from the standpoint of wave mechanics, the effects of relativity and spin being considered.
F. S.

1475. Action of the [Internal] Electric Field on the Radiation of the Ions of Rare-Earth Compounds. R. Brunetti and Z. Ollano. ***N. Cimento,*** **6. *pp.* 345–355, *Nov.*, 1929.**

The alterations in the absorption spectra of rare-earth compounds are divided into two categories. Those which occur when the crystal structure of the compound is unaltered, as with change of temperature; and those in which the crystal structure is changed. Mechanisms are proposed to account for each type, the former being explained by the variation in the intramolecular field, and the latter requiring consideration of the space distribution of the electric field, as affecting the probability of electron transitions.
J. H. A.

1476. Analysis of Diaphragm System for X-Ray Standard Ionisation Chamber. L. S. Taylor. *Bureau of Standards, J. of Research*, 3. *pp.* 807–827, *Nov.*, 1929.

Several observers have shown that an arbitrary choice of diaphragm system, for defining the X-ray beam in standard measurements, may introduce an uncertain error in the fundamental determination of the International *r* X-ray unit. A geometrical analysis shows that under certain experimental conditions the X-ray tube focus may be considered as a point source of radiation, while under other conditions it must be considered as an extended source. The difference between the two is considerable, and cannot be neglected. Curves are given showing the experimental conditions which must be used with a given X-ray tube and a standard ionisation chamber. An approximate measurement is made of the radiation coming from parts of the target face other than the focus, and it is shown how this may introduce error in the measurements. The energy distribution over the area of the beam was calculated, and measurements made photographically gave good agreement with the calculations—indicating clearly the region of the beam that must be used to insure uniformity within the prescribed limits of accuracy. An analysis of the several standard ionisation chambers used in other laboratories showed with one exception that their error in defining the beam was less than 0·5 %. AUTHOR.

1477. Precision Measurements of X-Ray Wave-Lengths. M. Siegbahn. *Arkiv f. Mat., Astron., och Fysik, Stockholm*, 21A. 21. [20 *pp.*], 1929.

A condensed report of methods and instruments used in the Physical Laboratory of Upsala University for the precision measurement of X-ray wave-lengths. As standard values for reference in relative measurements the $K\alpha_1$ lines recommended are Fe 1·932(076), Cu 1·537(396) and Mo 0·707(831) Å. Of second importance a list of seventeen $K\alpha_1$ lines covering the range 0·490 to 2·290 Å. is given, the values being not quite so accurate as those of the previous three. The improvements of the last two years are due partly to the use of some exceptionally good calcite crystals and partly to the refinements in methods, and in the instruments illustrated in this paper. W. H. GE.

1478. Origin of Spark Lines in X-Ray Spectra. B. B. Ray. *Phil. Mag.* 8. *pp.* 772–778, *Nov.*, 1929.

A critical review is given of the theories which have been proposed to explain the spark lines in X-ray spectra. A new explanation is put forward in which it is suggested that these lines arise if in the process of excitation two electrons are ejected simultaneously, one from K_1, and the other from L_1, with a subsequent rearrangement in which one electron passes from L_2 to K_1. F. J. W.

1479. Production of X-Radiation According to Wave Mechanics. A. Sommerfeld. *Frank. Inst., J.* 208. *pp.* 571–588, *Nov.*, 1929.

The problem of diffraction of a beam of electrons by an atom is solved by an exact method in place of the perturbation method. The solution obtained corresponds to elastic scattering. The X-radiation which accompanies inelastic scattering is obtained by the following method. The stationary wave solution Ψ_1 of the wave equation, corresponding to electrons impinging with energy E_1 on the unexcited atom and being elastically scattered, is combined with Ψ_2, the stationary wave solution corresponding to electrons of energy $E_2 < E_1$ impinging on the excited atom, and being elastically scattered, to give $\rho_{12} = \Psi_1\Psi_2^*$, the combined charge density, from which the radiation emitted is computed by the standard method. A formula for the angular distribution of X-ray intensity is obtained. It is shown that the shift of the direction of maximum intensity towards the incident direction, *increases* with increasing softness of the emitted X-rays. This result is in quantitative agreement with Kulenkampff's measurement on the X-rays emitted by bombarding very thin aluminium foils. It is further shown that the polarisation of the X-rays will be complete, and the intensity equal zero in the incident and reverse direction, only for the short wave-length limit of the continuous spectrum. These results are in general agreement with experiment. W. S. S.

1480. Angular Intensity Distribution of Continuous X-Ray Spectrum. Y. Sugiura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 207. *pp.* 251–290, *Oct.* 15, 1929. *In English.*

The intensity of the continuous X-ray spectrum is derived from the retarded coordinate matrices corresponding to transitions between the stationary state consisting of a nucleus scattering electrons of energy E_1 incident in a given direction, and the stationary state consisting of the nucleus scattering electrons of energy $E_2 < E_1$, no particular direction prescribed. If the wave functions ψ_1 and ψ_2 correspond to these two stationary states, the retarded matrix component for a coordinate x is given by $\int x e^{-2\pi i \frac{\nu}{c} nr} \psi_1^* \psi_2, dv$ where the integral extends over the whole space, $h\nu = E_1 - E_2$, n is the unit vector in the direction of observation, and r is the radius vector to the field point. The results give the observation direction at which the X-ray intensity is a maximum, for any X-ray frequency, and also the variation of polarisation with observation direction. Agreement between the theoretical values and Kulenkampff's experimental results is satisfactory. The essential feature of the present calculations is the use of the retarded matrix elements which allow for the phase relationship between the radiation emitted by different parts of the system. [See Sommerfeld, preceding Abstract.] W. S. S.

1481. New Wave-Length Standard for X-Rays. A. H. Compton. *Frank. Inst., J.* 208. *pp.* 605–616, *Nov.*, 1929.

A discussion of the discrepancies in results of X-ray wave-length measurements made with crystals and with ruled gratings. The improvements in technique of the grating method are compared and illustrated. It is concluded that the work of Bearden reaches much higher precision than was previously obtained and his measurements result in a wave-length 0·24 % greater than Siegbahn's made with crystals. The difference is about 25 times the probable error in his measurements, and seems to indicate a hidden error in wave-length estimates based on crystal diffraction. A careful consideration of various factors affecting grating wave-lengths fails to reveal any source of unreliability. Physical constants deduced from the grating wave-length values show considerable divergence from accepted values. An allowance in crystal density measurements due to crystal imperfection only serves to make the discrepancies greater, and the reason for the established difference between crystal and grating wave-lengths remains an open question. W. H. Ge.

1482. Attenuation Coefficients of Certain Gases for Short-Wave X-Rays. K. Schocken. *Zeits. f. Physik,* 58. 1–2. *pp.* 39–47, 1929.

Measurements were made on air, oxygen, nitrogen and argon, using monochromatic X-rays and varying the attenuation coefficient by changing the pressure of the gas. It is shown that for a formal representation of the results the scattering coefficient must be assumed to vary with the X-ray wave-length. If this occurs in accordance with the Compton theory, the scattering coefficient $\frac{\sigma}{\rho} = 0 \cdot 201 \Big/ \left(1 + \frac{2h}{m\lambda}\right)$ and assuming this law, the measurements give for the attenuation coefficient $\frac{\mu}{\rho} = C\lambda^{2 \cdot 4} + \frac{\sigma}{\rho}$, where C is a constant for each gas, and equals 1·48 for air, 16 for argon. The index 2·4 differs from the usual value 3, and this point is discussed in detail. W. S. S.

1483. Total Reflection of Long Wave X-Radiation. M. Schön. *Zeits. f. Physik*, 58. 3–4. *pp.* 165–182, 1929.

Apparatus and method are described for determining the angle of total reflection for long-wave X-rays using a photographic system. The total reflection of mirrors of glass, diamond, quartz and aluminium in the range 3 to 13 Å. was investigated. The variation in the critical angle of total reflection with wave-length was found to agree in the region of normal dispersion, with the Drude–Lorentz theory. Anomalous dispersion was found in the neighbourhood of the K edge, for aluminium. The measurements also give qualitative agreement between the observed variation of reflected intensity near the critical angle, and that computed from Fresnel's formula. W. S. S.

1484. Recoil of Electrons in the Compton Effect. G. Wentzel. *Zeits. f. Physik*, 58. 5–6. *pp.* 348–367, 1929.

The distribution of direction of recoil among the electrons which are engaged in scattering in the Compton effect is calculated using Dirac's method. In the limiting case of large recoils, the distribution becomes that which the Compton effect requires in free electrons. A. C. M.

1485. Precision Measurements in K-Series of Cadmium and Indium. J. Valasek. *Phys. Rev.* 34. *pp.* 1231–1233, *Nov.* 1, 1929.

The wave-lengths of the α_2, α_1, β_3, β_1 and β_2 lines in the K-series of cadmium and indium were re-measured, using the precision spectrograph of Siegbahn and Larsson. AUTHOR.

1486. Precision Measurements of Lines in the K-Series of Titanium and Vanadium. S. v. Friesen. *Zeits. f. Physik*, 58. 11–12. *pp.* 781–793, 1929.

Second order determinations of the wave-lengths of seven lines of the K-series of titanium and vanadium. G. C. McV.

1487. Determination of L Series of Elements from Copper (29) to Calcium (20) Using a Plane Grating Spectrograph. G. Kellström. *Zeits. f. Physik*, 58. 7–8. *pp.* 511–518, 1929.

Using a plane glass grating of 591 lines/mm. the L series for the elements copper (29) to iron (26), chromium (24), and titanium (22) to calcium (20), have been measured. The spectral range covered was from the CuLα (13·32 Å.) to the CaLl (40·90 Å.). Each element gave two lines corresponding to the doublets $\alpha\beta$ and $l\eta$. It is found that the intensity of the Lα line decreases with the atomic number, so that with calcium the $l\eta$ doublet is much stronger than the $\alpha\beta$. F. J. W.

1488. M-Series Absorption Spectra of Metallic Platinum and Gold. A. J. M. Johnson. *Phys. Rev.* 34. *pp.* 1106–1114, *Oct.* 15, 1929.

The M-absorption spectra of metallic platinum (78) and gold (79) have been investigated by the use of a vacuum spectrograph. Five discontinuities were found for platinum at 5·711 Å. (M_1), 5·506 Å. (M_2), 4·677 Å. (M_3), 4·085 Å. (M_4), and 3·742 Å. (M_5). For gold, four were found at 5·506 Å. (M_1), 5·315 Å. (M_2), 4·501 Å. (M_3) and 3·603 Å. (M_5). No M_4 discontinuity was found for gold, and the M_4 for platinum was very faint. The $(\nu/R)^{1/2}$ values for the experimentally determined edges compare very favourably with the values predicted by the use of absorption and emission data from the L-series except in the case of M_1 and M_2, where an unmistakable deviation, previously reported by other investigators on other elements, appears to be confirmed. No measurable shift in the position of any of the discontinuities due to a change in valence of four, in the case of the platinum atom, was observed. No " white line " absorption was observed at any of the discontinuities. AUTHOR.

1489. Quantitative Chemical Analysis by Means of the X-Ray Spectrum. H. Schreiber. *Zeits. f. Physik,* 58. 9–10. *pp.* 619–650, 1929.

The method of Hevesy and Coster, for estimation of the relative proportions of chemically similar elements, by means of kathode-ray excitation of the X-ray spectrum, is discussed in relation to sources of error. Spectrographs taken by the Debye method show that, at the high temperature used, chemical change can occur which alters the relative surface concentration of mixtures on the tube target, a fact first observed by Coster and Nishina. In the author's method the substance under test is excited by primary X-rays, and, whereas diffusively reflected electrons are still present, they have little practical effect. The apparatus used is illustrated, and this method can be applied to the examination of liquids. This " fluorescence " method is illustrated by results with varying mixtures as vanadium steel, mixtures of rare earths, etc., and it is shown that foreign substances present have little influence. The sources of error of the method are discussed and the maximum error is considered to be 7 %. [See also following Abstract.] B. J. L.

1490. Quantitative Chemical Analysis by means of X-Rays and its Application. G. Hevesy. *Nature,* 124. *pp.* 841–843, *Nov.* 30, 1929. *Paper read before the British Assoc., Johannesburg, Aug.,* 1929.

Quantitative estimations of elements present in a mixture may be made by observation of the intensity of X-ray spectral lines relative to the intensity of the lines of a reference substance. Secondary X-rays are preferably used for bombardment as the disturbing effects of kathode rays are so eliminated [see preceding Abstract]. The method has application in determinations of rare elements present in only small amount, and where chemical methods of estimation fail, as well as in cases of failure of the analogous spectral method with visible light, since the compounds are very refractory. Other applications are the determinations of the rarer elements in the earth's crust and meteorites, the analysis of soils for phosphorus, etc., and of alloys. In collaboration with Coster, the author used the method for the separation of hafnium and zirconium, where tantalum oxide was the reference substance, and it has also been used in the estimation of tantalum and niobium. B. J. L.

RADIOACTIVITY.

1491. Probability Law Governing Disintegration of Radioactive Materials in Very Small Concentration. G. I. Pokrowski. *Zeits. f. Physik*, 58. 9–10. *pp.* 706–709, 1929.

Describes a simple experiment which shows that for α-rays, using very small concentration in the preparation and large angular aperture, systematic and regular deviations from the ordinary probability laws of radioactive disintegration can be observed. This apparently points to the conclusion that the disintegration of an atom is not independent of that of a neighbouring atom. In conclusion the possibility of activating radioactive materials by radiation of short wave-lengths is pointed out. The results obtained in this direction, though they require confirmation, seem to be of greater certainty than the activation of lead, and the increase in the activity of polonium by solar radiation, reported by Deslandres and by Maracineanu. H. N. A.

1492. Detection of Products of the Atomic Disintegration of Aluminium. H. Pose. *Phys. Zeits.* 30. *pp.* 780–782; *Disc.*, 782, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

The method employed made it possible to record photographically by means of an electrometer the ionisation produced by a single H-ray. α-rays from polonium were sent through gold foil of different thicknesses, so as to obtain different residual velocities, and fell on an aluminium foil in which H-particles were produced. These were absorbed by different thicknesses of sheet mica, and curves were plotted showing the effect of absorption for H-rays of different velocities; these indicated that in the beam of H-particles produced by α-rays with a range of 3·72 cm. there were a number with small ranges, up to about 30 cm., a second group with ranges up to 47 cm., and, finally, a small number with ranges above 60 cm. It was also possible to determine the relative number of ions produced per single H-particle for different absorptions. The curve given shows a maximum at about 23 cm. air absorption, and another at about 45 cm. The latter point is where the number of particles begins to diminish rapidly, and the action resembles that shown in Bragg's curve for α-particles, showing that H-particles at the end of their range produce a large ionisation. H. N. A.

1493. Observation of the Products of Atomic Disintegration by the Ionisation Method. E. Walles. *Arkiv f. Mat., Astron., och Fysik, Stockholm*, 21A. 24. [12 *pp.*], 1929.

The α-rays of polonium passed through the gases investigated, the pressure being varied from one experiment to another. The resulting H-rays passed out through an opening in the chamber, closed by a sheet of nickel and a mica film, which prevented the α-rays from escaping. The H-rays went on into an ionisation chamber formed of a large soap bubble. The fact that the ionisation increased with increased pressure of the gas in the disintegration chamber was interpreted as being a sign of the presence of H-rays; this was distinctly noticed in the case of nitrogen, certain conclusions are drawn from a study of the ionisation-gas pressure curve. O_2, CO, CO_2 and SO_2 give indications that the production of H-rays with a range over 5·9 cm. is very small; smaller ranges would give no indication in the apparatus. So-called natural H-rays, produced by collisions of α-particles with H_2 molecules, were found when experiments were made with hydrogen, and with oxygen containing 4·8 % of hydrogen. [See also two following Abstracts.] H. N. A.

1494. Soap Bubbles as Ionisation Chambers. G. Ising. *Arkiv f. Mat., Astron., och Fysik, Stockholm,* 21B. 6. [3 pp.], 1929.

The advantages of using soap bubbles for the purpose are that they provide conducting walls with a thickness of less than 10^{-3} mm., which give a sharp boundary to the ionisation chamber, and are almost impermeable to air. If the chamber becomes contaminated with radioactive substance a new bubble at once provides a new and inactive one. [See also preceding Abstract and following Abstract.] H. N. A.

1495. Determination of Eve's Number with a Soap Bubble as Ionisation Chamber. E. Walles. *Arkiv f. Mat., Astron., och Fysik, Stockholm,* 21B. 7. [4 pp.], 1929.

The value obtained for Eve's number for the hard γ-radiation from radium, after correcting as far as possible for the effect of secondary radiation, was $3 \cdot 76 \times 10^9$. [See also two preceding Abstracts.] H. N. A.

1496. Measurement of Heat Emission of Uranium, Thorium and Radioactive Minerals by Means of the Adiabatic Calorimeter. (Miss) A. Dorabialska. *Acad. Polonaise Sci. et Lettres, Bull.* 8A. *pp.* 487–496, *Oct.*, 1929.

By means of the adiabatic calorimeter previously described [see Abstract 389 (1928)] the rate of emission of heat in gm.-cal./hr. (× 10^5) has been determined as follows: uranium (using urano-uranic oxide) 11·21 ± 0·15, thorium (using the dioxide) 2·16 ± 0·14, and pitchblende (from Joachimstal) 6·37 ± 0·19, which last gives for uranium the figure 11·0. The theoretical figure for uranium is 9·5. It is inferred that the uranium and thorium oxides used contained traces of more active substance, and that the theoretical figure is too low. Results agree well with those previously obtained. The specific heat of pitchblende similarly determined is 0·0809. C. A. S.

1497. Thermo-Dissociation of Atomic Nuclei with a Remark on Jeans' New Theory. S. Suzuki. *Phys. Math. Soc. Japan, Proc.* 2. *pp.* 119–138, *Nov.*, 1929. *In English.*

Lays stress on the important part which physical condition, especially the pressure, plays in nuclear thermo-dissociation. Corrections are made to the author's previous dissociation formula. An expression for the free energy of an assemblage of various nuclei and electrons is obtained, using statistical mechanics, special attention being paid to their mutual electric action as well as their excluded volumes. Obtains the dissociation formulæ of the radium and helium nuclei, and shows that an enormous temperature is still required with the new formula in order to obtain nuclear disintegration. An explanation of the appearance of Novæ is attempted, making use of the temperature pressure dissociation diagram. H. N. A.

1498. Rate of Disappearance of Radium D. Mme. P. Curie and Irène Curie. *J. de Physique et le Radium,* 10. *pp.* 385–387, *Nov.*, 1929.

Observations begun in 1907 were continued with additional precautions until 1926, by which time it was inferred from certain irregularities that the sample of radium D under observation contained a small amount of radium. The experiment was accordingly stopped and the suspicion verified. Corrected for this, the period of radium D is 19·5 ± 1·0 years. This longer period is supported by the observations so far carried on for 5½ years on preparations of radium (D + E + F) formed in old tubes of radon, which indicate a period lying between 19 and 24 years. [See also following Abstract.] C. A. S.

1499. Amount of Polonium Accumulated in Old Radon Tubes, and the Period of Radium D. Irène Curie. *J. de Physique et le Radium*, 10. *pp*. 388–391, *Nov*., 1929.

The period of radium D has been deduced from the quantity of polonium present at a definite epoch in the mixed radium (*D* + E + F) formed by the destruction of a definite amount of radon, the period of radon being taken as 3822 days, and that of polonium as 140 days. The most reliable results give for radium D a period of 23 years as against 19·5 years arrived at directly. The difference is discussed but not explained, and pending further experiments one of 21 years is suggested. [See Abstract 196 (1929) and preceding Abstract.] C. A. S.

1500. Radioactive Platinum Concentrates. W. F. Seyer. *Roy. Soc. Canada, Trans*. 23. *Sect*. 3. *pp*. 75–76, *Jan*., 1929.

A summary is given of the results of examination of black sands from different parts of British Columbia as to their platinum content and radioactive properties. The radioactive substances found were definitely associated with the platinum concentrates. J. J. S.

1501. Upper Limits of Energy in the β-Ray Spectra of Actinium B and Actinium C″. B. W. Sargent. *Cambridge Phil. Soc., Proc*. 25. *pp*. 514–521, *Oct*., 1929.

Absorption curves in paper were obtained for the β-rays of actinium (B + C) and actinium C″. Inferences regarding the shape of their energy distribution curves are drawn and the ranges of the β-rays of actinium B and actinium C″ fix their maximum β-ray velocities at Hρ3430 and 6140. The value of the method is pointed out for elements which cannot be easily investigated directly in a magnetic spectrograph. The γ-ray ionisations of actinium B and actinium C″ are compared under the same conditions with the β-ray ionisation of actinium C″. J. J. S.

1502. β-Particles of Very Small Energy. N. Feather. *Cambridge Phil. Soc., Proc*. 25. *pp*. 522–529, *Oct*., 1929.

A preliminary investigation of β-particles of small energy emitted during radioactive transformation is described in which a type of gold leaf source suitable for use with an expansion chamber is developed. Such a source is necessary for the detailed examination of β-particles of energy less than about 50,000 electron volts by the Wilson method. An outline is given of some results obtained with sources of radium D and thorium B + C of this type. J. J. S.

1503. Emission of β-Rays in Radioactive Change. L. B. Loeb. *Phys. Rev*. 34. *pp*. 1212–1216, *Oct*. 15, 1929.

To account for the β-ray emissions (with nondescript velocities) which occur sandwiched between α-ray emissions (with constant energy) it is assumed that in αββα transformations, the energies of the succeeding

β-rays supplement each other, thus giving a constant energy difference for the two α transformations. In $\alpha\beta\alpha\beta\alpha$ transformations, the β-ray energy differences must be supplemented by γ-ray changes. Either this is the explanation of the mechanism of the transformations or (*a*) β-rays are emitted at uniform velocities from the nucleus; or (*b*) β-ray and α-ray changes are independent of each other; or (*c*) the law of conservation of energy ceases to apply in nuclear changes. None of these alternatives is at all satisfactory. G. C. McV.

1504. Time of Passage of Particles through Region of "Negative Kinetic Energy." J. Kudar. *Zeits. f. Physik,* 58. 1–2. *pp.* 48–51, 1929.

The wave mechanics conception that the ratio of the probability current vector to the probability density (Dirac) equals the particle velocity, is applied to the case of a stream of particles of energy E impinging on a potential wall of height $U > E$. On the classical theory the particles could never penetrate the potential wall which would correspond to a region of " negative kinetic energy." On the wave mechanics, however, penetration would occur, and using the above conception of particle velocity the time taken for the particle to pass through the " wall " is derived. W. S. S.

1505. Scattering of Thorium C″ γ-Radiation by Radium G and Ordinary Lead. W. Kuhn. *Phil. Mag.* 8. *pp.* 625–636, *Nov.,* 1929.

The author has obtained a negative result in testing the existence of a possible nuclear resonance of thorium D nuclei for some γ-lines of thorium C″. The method adopted was to compare the scattering of thorium C″ γ-radiation by the lead isotope radium G and by ordinary lead. It was found that the nuclear effect produced in ordinary lead is at least 200 times smaller than the electronic scattering. As a possible explanation of this negative result the most reasonable assumptions that can at present be made seem to be that (1) the γ-rays are emitted by helium nuclei; (2) a time interval of about 10^{-10} sec. elapses between the emission of the β-rays and that of the γ-rays; (3) the resonance line, in the case of thorium D, must have a rather short wave-length; (4) the movements of the α-particle cause the residual nucleus to move in such a way that the centre of gravity is at rest. T. B.

1506. Electron Scattering and High-Frequency Radiation. J. A. C. Teegan. *Phil. Mag.* 8. *pp.* 664–667, *Nov.,* 1929.

Assuming that the Klein–Nishina formula for the absorption of γ-type radiation can be applied to electron waves, it is shown that electrons corresponding to 940 million volts would behave as regards absorption by matter in a manner almost identical with that of a γ-radiation of corresponding wave-length ($0{\cdot}013 \times 10^{-11}$ cm.). It would follow that the nature of highly penetrating cosmic rays, particles or light quants, could not be determined by a study of their absorption. W. S. S.

1507. Penetrating Hess Radiation. E. Steinke. *Phys. Zeits.* 30. *pp.* 767–771; *Disc.,* 771, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.,* 1929.

An account of observations, which are to be continued, carried out at sea-level, which confirm the sidereal time variations of the so-called radiation of the heights. J. J. S.

HEAT.

1508. Thermal Conductivity of Snow. M. Kuroda. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 218. *pp.* 149–159, *Nov.* 15, 1929. *In English.*

The temperature of snow was measured at different depths every three hours during a period of twenty-five days, and with the data obtained calculations are made of the thermal conductivity. The time—surface temperature curves when plotted are found to be of two types, namely, those where surface temperature does not reach the melting point, and those where the temperature remains nearly constant at or about that point, indicating that some snow has probably melted. The mathematical treatment of the data is given, and the results show that the value for the thermal conductivity obtained is rather above the values obtained by other observers, and in connection with the second type of curve it is demonstrated that the sink of snow layer as observed agrees very fairly with the calculated amount. J. G. H. B.

1509. Thermal Conductivity of Ice between 0° and — 125° C. M. Jakob and S. Erk. *Zeits. f. techn. Physik,* 10. 12. *pp.* 623–624, 1929. *From the Reichsanstalt. Paper read before the Deut. Phys. u. Math., Prague,* 1929.

The plates of ice used were frozen between two horizontal copper plates, the upper one being heated electrically and the lower cooled with liquid air. The whole arrangement was surrounded with a Dewar vessel. It was found that there was a temperature jump at the surface separating ice and copper, which may be due to the difference between the thermal expansion of ice and copper, or to an adsorption phenomenon at the boundary. Taking this into account, it was found that the conductivity of ice rises with falling temperature, as is to be expected for a crystalline substance; it is 0·00533 [cal. cm.$^{-1}$, s^{-1}, degree^{-1}] at 0° C. and 1·8 times as large at — 130° C.; it is four times as large at 0° C. as the conductivity of water at that temperature. At — 10° the measurements are accurate to ± 2 %; at lower temperatures the differences between measurements with different plates were greater. H. N. A.

1510. Measurement of Thermal Conductivity by a Modification of Kohlrausch's Method. R. Holm. *Zeits. f. techn. Physik,* 10. 12. *pp.* 621–623, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

A modification of the electrical method used by Kohlrausch, Diesselhorst and Meissner, and suitable for high temperatures, is described. It has been tested on platinum up to 1000° C. Evidence is also given in support of a theory of metallic contact due to the author. J. H. A.

1511. Measurements in the Ultra-Hertzian and Heat-Wave Region. A. Glagolewa-Arkadiewa. *Zeits. f. Physik,* 58. 1–2, *pp.* 134–138, 1929.

Measurements using the ultra-Hertzian waves of the mass radiator showed a selective absorption of a thermocouple at $\lambda = 340\,\mu$. Using this thermocouple, measurements have now been made with the Boltzmann interference mirror, on the extremely long heat waves of the mercury-vapour lamp. The interference curves obtained are discussed and compared with those given by Rubens and v. Baeyer. W. S. S.

1512. Total Emissive Power of Bismuth. W. del Regno. *Accad. Lincei, Atti*, 10. *pp*. 77–83, *July*, 1929.

From the electromagnetic theory of light there can be deduced theoretically the emissive power of a substance as a function of the absolute temperature and of the specific electric resistance. An account is given of a research on bismuth, a substance of which the law of emission deduced experimentally was unknown. Expressing the theoretical values and the experimental values obtained by the relation of the type $e = KT^m$ by which the emissive power is expressed, then for the theoretical value, $e = 19 \cdot 54 \times 10^{-5} . T^{1 \cdot 099}$ and for the experimental value, $e = 8 \cdot 28 \times 10^{-5} . T^{1 \cdot 116}$; and for $E = e\sigma T^4$, the total emission of the substance, the theoretical value $E = 11 \cdot 2 \times 10^{-16} . T^{5 \cdot 099}$ and the experimental value $E = 4 \cdot 769 \times 10^{-16} . T^{5 \cdot 116}$. It is probable that the two values, theoretical and experimental, of the exponent of T are equal, the difference between the two values being due to the difference of the coefficient K, which is a function of the specific resistance. The greater reflecting power than that obtained theoretically seems to indicate that in the phenomenon of reflection in bismuth not only do the free electrons participate, but also those of the atoms—that is, of the lattice—and that this contribution is considerable. J. J. S.

1513. New Calorimeter for Heats of Solution with an Application to Worked and Annealed Metals. C. J. Smith. *Roy. Soc., Proc.* 125. *pp*. 619–629, *Nov*. 1, 1929.

Gives details of earlier types of calorimeter used in investigation of the heat of solution of metals and full details of a new calorimeter on the continuous flow principle having a high sensitivity. The results of measurements of the heat of solution of cold-worked copper, zinc and brass are given and of the same metals in the annealed condition. The results show that the potential energy stored in cold-working accounts for the metals examined, only to about 1 % of the heat of solution. There is an Appendix to the paper on the potential energy of cold-worked metals by **C. H. Desch.** C. O. B.

1514. Apparatus for Determining the Expansion of Solids at High Temperatures. H. Gerdien and W. Jubitz. *Phys. Zeits*. 30. *pp*. 826–827, *Nov*. 15, 1929. *Paper read before the Deut. Physikerlag., Prague, Sept*., 1929.

This is a short description of a piece of apparatus developed by the authors. The specimen with plane parallel ends is placed in a tube furnace and supported at its centre. The temperature is measured with thermal couples or an optical pyrometer. The length is measured with callipers which touch the ends for short intervals of time, and can be withdrawn rapidly. The position of the callipers is determined electrically. Each moves a sliding contact on a wire carrying a current, and the potential difference on the wire between the two sliders enables the distance apart of the callipers to be determined. Details of construction and method of use with the necessary precautions to guard against the cooling of the specimen are given. T. B.

1515. International Temperature Scale between 0° C. and 100° C. J. A. Hall. *Roy. Soc., Phil. Trans.* 228. *pp.* 1–48, *Nov.* 28, 1929.

In consequence of the international agreement that the temperature scale between 0° and 660° C. shall be defined by a platinum resistance thermometer, using the formula $R_t = R_0(1 + At + Bt^2)$, thus formulating an International Temperature Scale [see Abstract 869 (1929)]. It became necessary to determine what change, if any, would be necessary to be made in the temperature scale used at the National Physical Laboratory by the adoption of the platinum resistance thermometer in place of the mercury in *verre dur* thermometer for interpolation between 0° and 100° C. The Tonnelot and Baudin thermometers in use at the N.P.L. were, therefore, compared with the platinum resistance thermometer, as also comparisons were made with thermometers made about the same time as those used by Chappuis in his original intercomparison with the gas thermometer. Full descriptions of the thermometers used and experimental details are given. The observations are set out in tabular form. In the examination of fifteen mercury in *verre dur* standard thermometers made by Tonnelot and Baudin, and calibrated at the Bureau International des Poids et Mesures, differences amounting to as much as 0·02° C. were observed between individual mercury thermometers. Comparisons were made against four platinum thermometers made at the N.P.L. The change from certain Tonnelot and Baudin thermometers to the platinum thermometer as a means of interpolation between 0° and 100° C., will not alter the temperature scale of the N.P.L. in that range by more than 0·002° C. between 0° and 50° C. or 0·005° C. between 50° and 100° C. The thermodynamic scale and the scale defined by the platinum thermometer were compared, the mercury in *verre dur* thermometers being used as intermediary. No difference was detected, and it is considered that such differences probably do not exceed a few thousandths of a degree between 0° and 50° C. or 0·01° C. between 50° and 100° C. S. G. B.

1516. Melting Point Curve of Helium. F. Simon, M. Ruhemann and W. A. M. Edwards. *Zeits. f. phys. Chem.* 6 *Abt. B.* 1. *pp.* 62–77, *Nov.*, 1929.

Particulars are given of the apparatus and methods employed by which the melting-point curve of He was determined over the region 12° Abs. and 800 atmospheres to 42° Abs. and 5600 atmospheres. The extrapolation formula given earlier [see Abstract 3374 (1929)] was found to apply within the limits of experimental error to this extended region of temperature and pressure. R. S. R.

1517. Apparatus for Testing Dühring's Law for Corresponding Boiling Points. E. F. Linhorst. *Am. Chem. Soc., J.* 51. *pp.* 3262–3265, Nov., 1929.

Two pure liquids are boiled in different parts of a closed system, comprising two Liebig condensers, the upper ends of which have a common connection to a vacuum pump, the lower end of each being fitted with a bulb for heating the respective liquids. As the pressure is varied in the system, the corresponding boiling temperatures can be observed directly. On employing the apparatus for benzene and ethyl alcohol against water, it is found that Dühring's law holds for the alcohol from 35° C. to 85° C., but not for benzene. A. J. M.

1518. Heat Capacity of Nitric Oxide from 14° Abs. to Boiling Point, and Heat of Vaporisation. Vapour Pressure of Solid and Liquid Phases. Entropy from Spectroscopic Data. H. L. Johnston and W. F. Giauque. *Am. Chem. Soc., J.* 51. *pp.* 3194–3214, *Nov.*, 1929.

Nitric oxide was prepared in a highly pure state, special care being taken to avoid contamination by air. The product contained less than 0·001 mol. % of impurity. The material was used for the determination of the heat capacities of the solid and liquid nitric oxide, over a range of temperature from 14° Abs. up to the boiling point 121·36° Abs. The melting point was found to be 109·49° ± 0·05° Abs. Calorimetric measurements of the heat of fusion and the heat of vaporisation were made. These were found to be 549·5 ± 1·0, and 3292·6 ± 3·0 cal. per mol. respectively. The entropy of nitric oxide gas at 121·36° Abs. and one atmosphere was calculated from the data obtained and from the third law of thermodynamics, and was found to be 42·94 ± 0·1 cal. per degree per mol. F. J. B.

1519. Relation between Specific Heat and Temperature. A. Denizot. *Pont. Accad. Sci., N. Lincei, Atti,* 82. *pp.* 344–356, 1928–1929. *Supplement.*

Tables are given in which the variation of the specific heat of the bulk of the solid elements are included, calculated values—based on the formula $C = a \log T$, where C is the specific heat and T the temperature—being compared with observed values where such exist. The author points out in a preliminary note that the values of the constant a when plotted against the atomic numbers give a definite curve. J. G. H. B.

1520. Determination of Cp/Cv. R. Rinkel. *Phys. Zeits.* 30. *p.* 805, *Nov.* 15, 1929.

Modifying an apparatus due to Rüchardt, it is shown that the ratio of specific heats of a gas may be determined by measuring the distance which a sphere falls in a glass tube before being brought to rest by the compression. J. H. A.

1521. Specific Heats of Tantalum, Tungsten and Beryllium. A. Magnus and H. Holzmann. *Ann. d. Physik,* 3.5. *pp.* 585–613, *Nov.* 23, 1929.

The specific heats of the three metals were studied over the range 100° to 900° C., using copper as the calorimetric medium. In the case of tungsten the results for the powdered metal are about 0·3 % higher than for samples of wire. The specific heat at constant volume is calculated from the results, and, in the case of tantalum, is found to be a linear function of the temperature, in contradiction to the theory of Debye, but in agreement with that of Born and Brody. The latter predicts that the specific heat should tend asymptotically to a straight line at high temperature, whilst that of Debye sets 3R as a limiting value. In the cases of tungsten and beryllium the graph of C_v against temperature is not rectilinear. To construct the Born and Brody asymptote, the authors assume that each measurement falls as far short of the asymptote, as the figure calculated by Debye's formula is short of 3R. By this means a number of points are plotted on the asymptote, which is found to be sensibly straight and to cut the line of zero temperature within 2 % of the value 3R, its theoretical position. The experimental results are as follows:

tantalum, $C_p = 6{\cdot}1742 + 1{\cdot}0093 \times 10^{-3}t$; tungsten wire, $C_p = 5{\cdot}8947 + 8{\cdot}338 \times 10^{-4}t$; beryllium, $C_p = 3{\cdot}5354 + 0{\cdot}88033 \times 10^{-2}t - 0{\cdot}11738 \times 10^{-4}t^2 + 0{\cdot}61307 \times 10^{-8}t^3$. J. H. A.

1522. New Method for Extrapolating Specific Heat Curves of Organic Compounds below the Temperature of Liquid Air.

K. K. Kelley, G. S. Parks and H. M. Huffman. *J. Phys. Chem.* 33. *pp.* 1802–1805, *Nov.*, 1929.

The authors briefly indicate the objections to previous methods, and point out that the new method has the following advantages, namely, that it is based on experimental data down to or below 20° K, is easy to apply and gives a reasonable degree of accuracy. The method consists in preparing standard molecular heat-capacity curves for the two classes of compounds, aliphatic and cyclic, as it is found that the different substances in each of these classes have curves of very similar character, and applying a factor for the particular substance, or by introducing a second constant as C_p (per mole) $= (A + BT)C_p^o$. Where C_p^o is the molal specific heat of the standard. From this it is found that

$$S_{90} = \int_0^{90} \frac{C_p dT}{T} = A \int_0^{90} \frac{C_p^o dT}{T} + B \int_0^{90} C_p^o dT = AS_{90}^o + B \int_0^{90} C_p^o dT,$$

where S_{90} is the entropy of the particular substance at 90° K., and S_{90}^o is that of the standard at the same temperature. Tables are given of the results obtained for a number of different substances. J. G. H. B.

1523. Latent Heat of Evaporation and Surface Tension.

W. Herz. *Zeits. f. Elektrochem.* 35. *pp.* 851–853, *Nov.*, 1929.

Data available for a number of liquids show that the increase in the heat of vaporisation with fall of temperature from the critical point diminishes for equal successive decrements of temperature to the reduced temperature 8/12. The increase in passing from the critical temperature to 11/12 is about one-half of that involved in the passage from 11/12 to 8/12. For surface tensions, the increase during the first one-twelfth fall in temperature is only 20 % of the total value, and is somewhat greater during successive falls. With non-associated substances, the ratios between the heat of vaporisation and the capillary constant are approximately equal at any one reduced temperature. T. H. P.

1524. Chemical and Vapour-Pressure Constants.

A. Eucken. *Phys. Zeits.* 30. *pp.* 818–826; *Disc.*, 826, *Nov.* 15, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

This investigation is an attempt to fill gaps in our knowledge of the properties of substances near the temperature of absolute zero. There is no purely thermodynamical method of determining whether the substance exists in (1) the Nernst state, *i.e.*, with one unequivocal arrangement; or in (2) a labile or frozen-in phase of more than one arrangement. Two examples illustrating these arrangements are met with in the case of sulphur and hydrogen. The starting point of the investigation is the equation for K_p, *i.e.*, $R \log K_p = -q_o'/T + \Sigma c_{p_0} \log T + \Sigma \phi_s + J_K$ (1), where $J_K = \Sigma j_k$, j_k being a true chemical constant. But according to Nernst's heat theorem $J_K = \Sigma j_p$, where j_p is the vapour-pressure constant, *i.e.*, the integration constant of the formula $R \log p = -l_o/T$

$+ c_{p_0} \log T + \phi_s - \phi_{\text{cond.}} + j_p$. Hence, we have to find j_k and j_p. If we find $j_k = j_p$, we must assume that the Nernst state exists, but if the difference between the two quantities is greater than the errors of observation, we must have the "labile" state. The experimental results which have been obtained are tabulated and discussed. The peculiarities in the cases of nitrogen, methane and carbon dioxide are considered in connection with the modification of the nucleus. A number of heterogeneous reactions in which a halogen occurs in the gas state are remarkable for a difference of 0·6 between the j_p and the j_k values. [See also following Abstract.] T. B.

1525. Vapour-Pressure Constants of Carbon Monoxide. K. Clusius and W. Teske. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 135–151, *Nov.*, 1929.

This paper was suggested by the investigation of Eucken [see preceding Abstract] on the vapour-pressure constant and the true chemical constant of various gases. In the case of the halogens and CO_1 values have been obtained by various authors which are outside the limits of error of experiment. A redetermination of the vapour pressure of CO was made by the help of a metal-block thermostat and a comparison of the vapour pressure of nitrogen and oxygen. Full details of the apparatus, with diagrams, and with the necessary precautions for obtaining pure materials, are given. Oxygen and nitrogen themometers are very suitable for the work, since the vapour pressure of CO lies between that of the other two gases. The two pressures to be compared were simultaneously read by two observers on kathetometers. The vapour pressure p and the vapour-pressure constant j_p were calculated from the equation:

$$\log p = -\frac{L_0}{4 \cdot 573T} + \frac{C_{p_0}}{R} \log T + \frac{1}{4 \cdot 573} \int_0^T \frac{dT}{T^2} \int_0^T \left(C'_{p_{\text{gas}}} - C_{p_{\text{solid}}}\right) dT + j_p.$$

The authors obtained for L_0 the value of 1904·6 cal., and for $j_p - 0 \cdot 066 \pm 0 \cdot 05$. The latter differs from the value $j_k = +0 \cdot 157$ as calculated from the Sackur–Tetrode equation. Suggestions are made to explain this discrepancy on lines suggested by Schottky in his *Thermodynamics*. T. B.

1526. Evaporation of Binary Mixtures. Part II. Theory. M. S. Wrewsky. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 359–384, *Nov.*, 1929.

The formation of saturated vapour from a mixture of two liquids is connected with the absorption of a quantity of heat which is not the sum of the heats of evaporation of the pure liquids. Further, the composition of the vapour formed is not the same as that of the mixed liquids. Hence, the phenomena of the formation of vapour from a solution must be considered as the result of two different processes, *i.e.*, the chemical reaction of the decomposition and the physical process of the change of the solution from one state to another. Both quantities can be found experimentally, and the author has by a cyclic process obtained a connection between the composition of the vapour, the heat of evaporation, and the differential heat of dilution. From the formulæ obtained, it was possible to classify different solutions and to give a rule which connects the form of the vapour pressure and the heat of formation of the solution curves with the form of the curve which represents the change of heat accompanying the evaporation with the concentration. A formula is also deduced which allows the composition of the vapour to be calculated from the thermal data. The deduction of the formulæ is fully given, and they are first applied to ideal solutions, *i.e.*, those which possess additive properties. The results are shown in numerous graphs. Results are given for alcohol and water, and nitric acid and water. [See also following Abstract.] T. B.

1527. Evaporation of Binary Mixtures. Part III. Heat of Evaporation of Aqueous Solution of Hydrochloric Acid. M. S. Wrewsky and G. P. Faermann. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 385–394, *Nov.*, 1929.

The object of this investigation was the experimental verification of the deductions made [see preceding Abstract]. The solution investigated was hydrochloric acid, and the experiments were carried out in the apparatus described previously [see Abstract 1121 (1930)], which was slightly modified, however, to meet the properties of the solution. The experiments were conducted at 78° C. and at 21° C., and the results are shown in curves. The observed values of the heat of evaporation agree within 1 % of the values calculated from Wrewsky's formula. The values calculated from thermal data of the composition of the vapour phase agree satisfactorily with the values found experimentally. T. B.

1528. Definition of Frequency. J. Q. Stewart. *Phys. Rev.* 34. *pp.* 1052–1055, *Oct.* 1, 1929.

If energy applied to change the moment of inertia of a rotating bar is taken as the analogue of work in thermodynamics, and energy applied to change its speed of rotation as the analogue of heat, then frequency is the analogue of absolute temperature, and can be defined by a process exactly corresponding to that by which absolute temperature is defined. The second law of thermodynamics is thus symbolically equivalent to a principle of mechanics. This paper illustrates the possibilities of purely formal studies of physical principles. AUTHOR.

1529. Thermodynamics of Caoutchouc. L. S. Ornstein, (Miss) J. G. Eymers and J. Wouda. *K. Akad. Amsterdam, Proc.* 32. 9. *pp.* 1235–1242, 1929.

The changes of breadth and thickness have been measured as functions of the stress, using fresh samples for each measurement, to avoid hysteresis. Young's modulus and Poisson's ratio show a discontinuity at a particular stress, and remain constant at stresses above this critical stress. This is taken to confirm the evidence previously obtained [see Abstract 3003 (1929)] that a new phase is formed during stretching. Röntgen photographs due to Katz suggest the same thing. Another method of avoiding hysteresis has been used, in which the extension from 0 to 100 % takes place in about ½ sec., the stress and strain being registered automatically. The linear coefficient of expansion of caoutchouc is positive, which appears contrary to the fact that it becomes warmed on stretching. The latter effect is shown to be due to the work of hysteresis. The coefficient of commercial vulcanised rubber is usually negative, and here the hysteresis is vanishingly small. J. H. A.

SOUND.

1530. Vowels. V. Engelhardt and E. Gehrcke. *Zeits. f. techn. Physik*, 10. 11. *pp.* 563–567, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

Two theories of vowel sounds have been advanced; the first, the "absolute" theory, views the characteristic curves of the vowels as built up of component tones of absolute pitch, while the second, or "relative" theory, views vowel characteristics as due to the relative ratios of the partial tones to one another. Experiments were carried out on the vowel character of pure sine wave tones, and the characteristic curves of the individual vowels were investigated. The results, which are expressed in the form of curves, tend to support both theories in certain respects. A. W.

1531. Directional Effects with the Human Voice. F. Trendelenburg. *Zeits. f. techn. Physik*, 10. 11. *pp.* 558–563, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

An experimental investigation was made of the directional effects of the human voice. Three regions were investigated: 200–400 cycles/sec., 3300–3600 cycles/sec., and about 6000 cycles/sec. The higher frequency regions were found to show pronounced directional effects in consequence of the mouth acting like a funnel. The directional effects observed were appreciably greater than were to be expected on theoretical grounds.
A. W.

1532. Theory of Hearing. G. v. Békésy. *Phys. Zeits.* 30. *pp.* 721–745, *Nov.* 1, 1929.

A lengthy series of experiments is described bearing on the theory of hearing. The experiments are concerned with the effect of the duration of the impulse, the rate of rise of intensity at the start of the impulse, the time interval between two tone impulses which are being compared, etc. The subject of interfering sounds is fully dealt with, and the whole of the results obtained are discussed with reference to the action of the various parts of the human ear. A. W.

1533. Measurement and Calculation of the Natural Frequencies of a System of Coupled Continua. E. Waetzmann and V. Schneeweiss. *Ann. d. Physik*, 3. 3. *pp.* 314–324, *Oct.* 30, 1929.

Examines theoretically and experimentally two similar systems to those examined by Waetzmann and Schuster [see Abstracts 692 and 693 (1928)]. One of the systems examined consists of a coupling cylinder closed at one end by a telephone diaphragm and a small diameter air column connected to the side opposite the diaphragm. The heights of the air column and coupling cylinder are both systematically altered, and the results obtained show good agreement with the theory. Further, a correction term in the theoretical formula for the natural tones is approximately examined, and it is found to be connected with the vibration profile of the air particles found in the boundary planes of the air column and the coupling column. It has the character of a fatigue correction, such as is applied to open pipes. The other system examined consists of an air space confined between two diaphragms of the same diameter, and measurements were made on both systems in order to study the influence of a mutual discord of the separate systems. R. C. F.

1534. Transmission of Air Waves to Great Distances. F. J. W. Whipple. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 72–75, 1929. *In English.*

Recent English observations of air waves due to gunfire show that the angle (α) of descent, and the velocities at the top of the trajectory (v) and at ground level (v_0) are related by $v = v_0 \sec \alpha$. These results indicate that (1) the temperature of the stratosphere is constant up to 30 km., (2) at 40 km. it has the value found at the ground, and (3) at the greatest heights reached in these tests by air waves (*e.g.*, 56 km.) a temperature of 380° Abs. This puts Gowan's figure for the base of the region of high temperature as too high. Evidence of the audibility of meteors exists for levels up to just above 50 km. but not to 60 km. If the maximum temperature occurs at 55 km. the air would be unstable and turbulent, and the energy of the waves would be rapidly damped. Evidence from meteor trails supports this view. R. S. R.

1535. Analysis of Noise. M. Grützmacher. *Zeits. f. techn. Physik,* 10. 11. *pp.* 570–572, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

Describes an electrical outfit by which the incident noises are automatically recorded and analysed. The examples given of the consonant "S," and the noises of a Bunsen burner and a suction dust-remover show the square of the amplitude of the sounds over the frequency range from 100 to 14,000 vibrations per sec. W. H. Ge.

1536. Sound Analysis with a String Electrometer. M. Grützmacher. *Zeits. f. techn. Physik,* 10. 11. *pp.* 572–573, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

The sounds to be analysed are transformed into fluctuating electrical currents with a microphone and amplifier, and are applied to the plates of the string electrometer. One point of the circuit is also applied to the string through a resistance to which can be applied an alternating potential of variable frequency. When the variable frequency agrees with that of one of the partial tones the string assumes a steady deflection. When the two frequencies are nearly equal the string vibrates with the frequency-difference of the two, and the amplitude is proportional to the product of the two applied potentials. An unknown frequency applied at 0·5 volt can be analysed if the variable frequency is of the order 200 volts. The string is tuned to a low frequency. W. H. Ge.

1537. Frequency of an Organ Flue-Pipe. A. E. Bate. *Phil. Mag.* 8. *pp.* 750–761, *Nov.,* 1929.

The vortex theory of edge tones is shown to apply in the case of the mouth of an organ pipe in that $\frac{V}{nh}$ = a constant, where V is the velocity of the air jet, n is the frequency of the note, and h is the height of the mouth. If V is in feet per second and h is in feet, the constant is 2 for ordinary edge tones; whereas it is large in the case discussed, and is given by $\frac{74}{3}(0 \cdot 3 - s)$, where s is the thickness of the jet in inches. An explanation of the deviation is offered, and this indicates that the diameter of the vortices is the same for the three slit-widths used, at all frequencies, for the same value of h, but increases with increase in height of mouth. Author.

ELECTRICITY AND MAGNETISM.

ELECTROSTATICS, TERRESTRIAL ELECTRICITY AND MAGNETISM.

1538. Electrification of a Two-Dimensional "Ice Pail." W. B. Morton and Mary McDonald. *Phil. Mag.* 8. *pp.* 761–764, *Nov.*, 1929.

Taking the two-dimensional analogue of Faraday's ice pail as composed of an infinitely long parallel-sided strip for bottom, with two strips of equal height to form perpendicular sides, the authors have worked out the configuration of the field when the arrangement is freely charged. The problem is treated by the general method of Schwarz, applicable to fields bounded by straight conductors, and the work follows closely the procedure adopted by one of the authors in an earlier paper on the electrification of two intersecting planes [see Abstract 1416 (1926)]. W. C. S. P.

1539. Factors Governing the Magnitude of Frictional Electric Charges. P. A. Mainstone. *Phil. Mag.* 8. *pp.* 733–749, *Nov.*, 1929.

The investigations of other observers are summarised. The apparatus used was of two types designed to obtain reasonably constant conditions in measuring the results due to very small amounts of mechanical work, and is fully described and illustrated. The materials used were brass, steel and silver, in each case in rubbing contact with glass, and experiments were conducted in air, hydrogen, nitrogen, and (in the case of silver) in oxygen, at pressures varying from a few mm. up to atmospheric pressure. The results (a number of which are demonstrated graphically) appear to show that: (1) Where a glass surface is rubbed on metal the charge shows marked variation with pressure, being a minimum over a range of about 1 to 10 mm. (2) At higher pressures the charge varies with the gas. (3) Variation of charge with pressure is independent of the capacity of the system. J. G. H. B.

1540. Piezoelectric Effect and Temperature. A. Perrier. *Zeits. f. Physik*, 58. 11–12. *pp.* 805–810, 1929.

Discusses the work of Dawson and Andreeff on the temperature effect upon piezoelectric properties of quartz and also the relation with the pyroelectric effect. Studies in the elastic properties suggest that β-quartz cannot show the piezoelectric effect. W. H. Ge.

1541. Electrical Charges Developed in Certain Amorphous Dielectrics under Pressure. A. Turpain and M. Durepaire. *Comptes Rendus*, 189. *pp.* 739–741, *Nov.* 4, 1929.

It has been shown that certain amorphous insulators, including rubber, ebonite and paraffin, develop charges under pressure. The main difference of potential is between the compressed faces, but secondary charges arise between other faces. Greater charges are obtained when the pressure is applied locally than when it is evenly distributed. The magnitude of the charge is independent of the thickness between 1 and 6 mm. Under a pressure of about 2 kg. per sq. cm. crêpe rubber develops some three e.s.u. of quantity, and smoked plantation rubber about 1½ e.s.u. G. E. B.

1542. Dielectric Constant and Association. J. Malsch. *Phys. Zeits.* 30. *pp.* 837–839, *Nov.* 15, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

Measurements of the dielectric constants in intense electric fields of a number of organic substances, *viz.*, methyl, ethyl, *n*-propyl, *n*-butyl, *n*-amyl and benzyl alcohols, and nitrobenzene, glycerin and water, give differences between the experimental and calculated values which are ascribed to association phenomena. A full discussion of the results is included. H. H. Ho.

1543. Dielectric Behaviour of Non-Conducting Liquids at Different Pressures. A. Nikuradse. *Zeits. f. techn. Physik,* 10. 12. *pp.* 641–647, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

Measurements in dielectric liquids at different pressures indicate two kinds of spark discharge: steady and variable. The steady discharge is regarded as a consequence of the current-voltage relationship, $J = J_0 e^{cV} = J_0 e^{c\delta F}$, where J = current in amp., J_0 is a measure of the ionisation strength of the liquid during spontaneous ion formation, *c* is the exponential constant, δ = electrode distance, *V* = voltage, and F = field strength, and appears to be independent of pressure. The variable discharge depends on pressure, and is to be explained by processes of a secondary nature. J_0 depends on temperature, electrode surface, electrode distance, and degree of purity of the liquid, but is independent of pressure (between 720 and 10 mm. mercury); *c* expresses the effect of the high field strength, and depends on δ, but is independent of pressure, temperature and electrode surface. H. H. Ho.

1544. Dielectric Polarisation of Liquids. Part VI. Ethyl Iodide, Ethanol, Normal-Butanol and Normal-Octanol. Part VII. Isomeric Octyl Alcohols and Molecular Orientation. C. P. Smyth and W. N. Stoops. *Am. Chem. Soc., J.* 51. *pp.* 3312–3341, *Nov.*, 1929.

These papers continue the general investigation [see Abstracts 3646 (1929) and 275 (1930)], Part VI containing measurements over a wide range of temperature and concentration of the dielectric constants and densities of solutions of ethyl iodide in heptane and of ethanol, *n*-butanol and *n*-octanol. A qualitative indication of the anomalous dispersion and absorption for a wave-length of 600 m. has been obtained for the pure alcohols and their solutions. The dielectric polarisations of ethyl iodide give further evidence of the applicability of the Debye equation to liquids in very dilute solution. The polarisations of the alcohols are greatly affected by molecular orientation which, while interfering with the exact application of the Debye equation, do not, however, prevent the calculation of the electric moments of the molecules. It is concluded that the electric moment of the molecule of a primary alcohol is independent of length of the carbon chain. In Part VII, the measured dielectric constants of 22 isomeric octyl alcohols indicate a tendency towards anomalous dispersion and absorption for a wave-length of 600 m. The effects of molecular orientation in causing differences among the isomers are again observed, and the explanation of the values of the dielectric constants in terms of such molecular orientation is held to be consistent with the observed tendencies towards anomalous dispersion and absorption and with Stewart's results for X-ray diffraction measurements. H. H. Ho.

1545. Dipole Moments of Some Organic Molecules in Benzene Solution. O. Hassel and E. Naeshagen. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 152–158, *Nov.*, 1929.

In benzene solution dibenzyl ketone has a dipole moment of $2 \cdot 65 \times 10^{-18}$ and *n*-butyraldehyde $2 \cdot 46 \times 10^{-18}$, results which support the hypothesis that the — CO group is, in general, influenced by the phenyl group. Other values $\times 10^{-18}$ are: paraldehyde (1·9), benzoin (3·46), benzil (3·71), hydroquinone dimethyl ether (1·74), mononitrohydroquinone dimethyl ether (4·56). H. H. Ho.

1546. Electric Moments of Some Non-Rigid Molecules. A. Weissberger and R. Sängewald. *Phys. Zeits.* 30. *pp.* 792–801, *Nov.* 15, 1929.

In this paper methods are described (with accompanying data) for the determination of the electric moments of some non-rigid organic substances, together with data for their dependence upon the solvent used, and on the dimensions, chemical composition and configuration of the substituents employed. The substances were: quinol diethyl ether in solutions of benzene, carbon tetrachloride, cyclo-hexane and carbon disulphide respectively, some ethers (dimethyl, diethyl and di-*n*-propyl), benzene solutions of quinol ethers (dimethyl, diethyl, di-*n*-butyl and di-*n*-octyl), diethylbenzene and *p*-xylylenedichloride, and the dimethyl and diethyl ethers of quinol, resorcinol and catechol. H. H. Ho.

1547. X-Ray Investigation of Electric Polarisation of a Crystal Lattice. J. Hengstenberg. *Zeits. f. Physik*, 58. 5–6. *pp.* 345–347, 1929.

A high electric field is applied by metal plates on opposite sides of a crystal slice. The displacement of the ions thus produced is measured by X-rays. Observations on KCl for two different values of the field-strength are in agreement with those expected theoretically. A. C. M.

1548. Ions in the Atmosphere. L. Martinozzi. *N. Cimento*, 6. *pp.* 320–324, *Aug.-Sept.-Oct.*, 1929.

Method of measurement of the ionic density of the atmosphere. A. D.

1549. Ozone and Conductivity of the Atmosphere. E. Regener. *Gerlands Beitr. z. Geophys.* 24. 1. *pp.* 70–71, 1929.

Recent results obtained by Hellmann indicate that if conductivity is due to the decomposition of ozone less than one pair of ions occurs with the decomposition of $5 \cdot 10^{15}$ ozone molecules. The author considers that the effect observed by Brewer is misleading on account of temperature changes during the reaction, and that ozone cannot explain the changes of nocturnal conductivity. The effect of cosmic radiation in causing this ozone layer is discussed, but the maximum absorption appears to occur at 16 km. There may, however, be feebler components in this radiation at higher levels, but further observations are required. R. S. R.

1550. Ions and Electric Currents in the Upper Atmosphere. E. O. Hulburt. *Phys. Rev.* 34. *pp.* 1167–1183, *Oct.* 15, 1929.

It is assumed that the ionisation of the upper atmosphere is due to the ultra-violet light of the sun, and that the ion and electron densities at noon at the equator are those obtained from experiments on wireless wave transmission. From the laws of recombination of the ions and of diffusion and drift of the ions in the earth's magnetic, gravitational and electric fields the distribution of the ions over the earth is worked out. It is found to agree with the wireless data and with a diamagnetic, as opposed to a gravitational drift current, theory of the diurnal variation of the earth's magnetism. This theory gives eastward and westward flowing gravitational drift currents mainly along the 40th parallels of latitude, north and south, which give a net eastward current flowing continually round the earth. These currents result in an electric field being established between sunset and sunrise longitude, one effect of which is to delay the rate of recombination of the ions and electrons. Its effect on the Heaviside layer is also discussed. G. C. McV.

1551. Electric Field of the Earth. Part I. T. Schlomka. *Gerlands Beitr. z. Geophys.* 24. 2–3. *pp.* 241–272, 1929.

The volume charge of the earth's atmosphere is considered. The potential distribution will be affected by this charge, and in so far as the latter is unsymmetrical, there will be induced charges on the earth's surface, which may affect the potential appreciably. The following electrostatic problems are solved, in order to throw light on the matter: (1) inductive action of a charged spherical zone. or spherical segment, on a conducting sphere; (2) distribution of charge on a conducting sphere, surrounded by a conducting envelope, in the presence of a second sphere and envelope. J. H. A.

1552. Globular Lightning. Serpentine Forms. E. Mathias. *Comptes Rendus*, 189. *pp.* 813–815, *Nov.* 18, 1929.

The development of a bluish light in globular lightning and the transformation of the globular into a serpentine form are attributed to excessive diminution of surface tension through the presence of sulphur, the cylindrical form being more stable, within limits as regards decreasing diameter of the cylinder; if these are exceeded a slight shock causes the " serpent " to break up into numerous small spheres. [See Abstract 1146 (1930).] C. A. S.

CURRENT ELECTRICITY, MAGNETISM AND ELECTROMAGNETISM.

1553. Electrical Conductivity of Thin Metallic Films. M. Pierucci. *Accad. Lincei, Atti.* 9. *pp.* 990–996, *June* 1, 1929.

A further discussion of the thin tungsten films obtained from tungsten lamps [see Abstract 1970 (1928)]. Compares results with those of Bartlett, Patterson, Barlow and others. The author adheres to the opinion that thin tungsten films have a negative coefficient of resistance, and that his films have a thickness of about 5×10^{-7} cm. E. E. F. d'A.

1554. Measurements with the Aid of Liquid Helium. Part IV. Electrical Resistance of Gold in Magnetic Fields, with Remarks on Kapitza's Work. W. Meissner and H. Scheffers. *Phys. Zeits.* 30. *pp.* 827–836, *Nov.* 15, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

The electrical resistance of three samples of gold, including two single crystals, was measured in magnetic fields up to 13,000 gauss, at temperatures from 1·3° to 78·5° K. For strong magnetic fields dR/dH is independent of H and of temperature, where R is the resistance and H the field strength. The discussion given by Kapitza [see Abstract 2580 (1929)] for the relation between these effects and position in the periodic table is criticised, and a revised discussion offered. It is further noted that the change of resistance with field strength, at a fixed temperature, is not accurately represented by a hyperbolic relation. Theoretical work requires extension to take account of very low temperatures and high fields, before the results can be considered from a theoretical point of view. J. H. A.

1555. Measurements with the Aid of Liquid Helium. Part V. Superconductivity of Copper Sulphide. W. Meissner. *Zeits. f. Physik*, 58. 7–8. *pp*. 570–572, 1929.

The sulphide was prepared in rod form by heating copper wire in sulphur vapour. The conductivity increases normally down to 1·66° K, after which it increases rapidly, and the resistance cannot be measured at 1·55° K. J. H. A.

1556. Measurement of Electrical Resistance by Means of "Negative Resistance." H. Pauli. *Zeits. f. techn. Physik*, 10. 12. *pp*. 592–595, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

Describes methods of measuring effective resistance at any frequency by apparatus showing negative characteristics, such as the arc or valve. The resistance to be measured is incorporated in an oscillatory circuit containing, in general, a valve, and the effective resistance of the coil of other apparatus is determined from the apparent change in the characteristic of the valve. G. E. B.

1557. Conductivity of Solid Salts at High Temperatures. L. Jolland. *Comptes Rendus*, 189. *pp*. 743–745, *Nov*. 4, 1929.

If log conductivity is plotted against the inverse of absolute temperature a straight line is obtained up to a certain point, when a discontinuity occurs. According to Phipps, this change corresponds to the transition from mon-ionic to bi-ionic conduction. In the present paper the transition points for halogen salts, sulphates and carbonates of the alkalies and alkaline earths are given. In the case of Na, K and Ca the slope of the log C, 1/T curve suddenly doubles, and in the case of Ba and Sr is halved at the critical temperature. G. E. B.

1558. Mechanism of Ionic Conduction in Good Conducting Solid Compounds. W. Jost. *Zeits. f. phys. Chem*. 6. *Abt. B*. 2. *pp*. 88–102, *Nov*., 1929.

An exhaustive discussion of the mechanism of the conductivity of solid salts is given, wherein it is pointed out that extraordinary contradictions arise when Smekal's conclusions [see Abstract 2933 (1929)] are subjected to numerical evaluation. In consequence, Smekal's theory can hardly be regarded as valid. Objections which Smekal has raised to the present author's views are proved to be without foundation, and in conflict with thermodynamics. In a further reply (*Ibid*., pp. 103–110), **A. Smekal** attempts to uphold his previous conclusions, and considers the above objections to be without effect upon them. H. H. Ho.

1559. Behaviour of Bismuth in the Magnetic Field. R. Fedele. *Accad. Lincei, Atti*, 10. *pp*. 83–89, *July*, 1929.

Attempts to explain the variations with the magnetic field of the Hall effect, the thermoelectric power and the resistance of bismuth, setting out from the electronic theory have not been successful. The author has investigated whether a change in the structure of the metal has an influence on the three phenomena and has compared the variations shown by a paste made by compression from powdered bismuth with those occurring in ordinary bismuth. The changes which occurred in both cases, while differing in amount, were the same in kind, and seemed to be due to the orientation of the particles of Bi, which tended to set themselves with their principal axes along the lines of force of the field. If the field produces structural modifications, these have no effect on the variations of the Hall effect, the thermoelectric power and the resistance. Hence, such variations must be regarded as due exclusively to purely electro-dynamical actions, and the want of success in explaining them by the electronic theory should be numbered amongst the negative proofs of the theory itself. J. J. S.

1560. Disturbance of Superconductivity of the Compound Bi_5Tl_3 and of the Alloys Sn-Sb and Sn-Cd by Magnetic Fields. W. J. de Haas and J. Voogd. *K. Akad. Amsterdam, Proc.* 32. 7. *pp.* 874–882, 1929. *Comm. No.* 199c *from the Phys. Lab., Leiden.*

Investigation of the magnetic disturbance of the superconductivity of Bi_5Tl_3 showed that the fall of the magnetic threshold value with decreasing temperature is much steeper here than for pure superconductors. In order to find whether this is a general property of alloys, solid solutions of Bi in Sn and of Cd in Sn were examined. The eutectics of the systems Sn-Bi and Sn-Cd were especially used. The results are given in a series of tables, and from them it appears that in all cases investigated the value of $H_{w\frac{1}{2}}$, *i.e.*, the magnetic field for which the resistance is restored to half its original value, increases more rapidly with decreasing temperature than in the case of the pure superconductors. Or, for the same temperature distance from the transition point, higher field intensities are required to restore the resistance. This unexpected result may become of use in magnetic researches because of the high values of $H_{w\frac{1}{2}}$ found for Bi_5Tl_3. At 3·4° K. a field of 5·3 kilogauss did not yet disturb the superconductivity of Bi_5Tl_3. An extrapolation of the data would predict that at a temperature of 1·3° K. a field of about 9 kilogauss would not yet disturb the superconductivity. This would render possible the production of magnetic fields of this order of magnitude with a solenoid of Bi_5Tl_3 wire without production of heat. Independently of this possible practical application, the phenomenon itself is of the highest importance.

J. J. S.

1561. Thermodynamics and Kinetics of Thermoelectric Phenomena in Crystals, Especially the Bridgman Effect. P. Ehrenfest and A. J. Rutgers. *K. Akad. Amsterdam, Proc.* 32. 7. *pp.* 883–893, 1929.

Referring to their former paper [see Abstract **3404 (1929)**], the authors point out that a small modification of the fundamental hypotheses of the Lorentz theory is sufficient in order to obtain the Bridgman effect, and besides the classical distribution of velocity would be retained. Two assumptions are required: (1) the mean free length of path of an electron depends on its velocity; (2) this dependence varies with different directions of motion within the crystal. The consequences of these hypotheses are developed mathematically in the paper. J. J. S.

1562. Long Direct-Current Arcs in Air. A. v. Engel. *Zeits. f. techn. Physik,* 10. 11. *pp.* 505–508, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

Measurements of current density, influence of velocity of air, electric field-strengths in the arc axis under different current strengths, influence of the diameter of the tube. A. D.

1563. Glow Discharge. M. Steenbeck. *Zeits. f. techn. Physik,* 10. 11. *pp.* 480–483, 1929. *Paper read before the Deut. Phys. u. Math. Prague,* 1929.

An experimental investigation was made of the time required to build up the glow discharge, a Braun tube being employed to obtain oscillograms of the discharge current. At low pressures the results obtained were in agreement with Townsend's theory. It was found that with abnormal current densities the discharge current passes through a maximum before reaching its stationary value. This effect is explained. A. W.

1564. High-Frequency Discharge through Rarefied Gases. Y. Asami. *Hokkaido Imp. Univ., Eng. Mem.* 2. *pp.* 1–20, *Oct.,* 1929. *In English.*

Using a neon glow-lamp, it was found that three types of stable discharges could be observed in sequence as the terminal voltage is varied, under the influence of h.f. currents. The appearance of the three types depends on the frequency, and also on the superimposed d.c. If the d.c. voltage is low all three types can be obtained, but when it is high only one or two types are obtained. With h.f. all three types can be observed with suitable d.c. supply, but if the frequency is low only one or two types of discharge are found. A. W.

1565. Effect of High-Frequency Discharges on the Dissociation of Gases. M. J. Marshall and E. H. Nunn. *Am. Electrochem. Soc., Trans.* 55. *pp.* 119–129, 1929.

The degree of dissociation of various gases in the high-frequency discharge has been measured, by noting the almost instantaneous pressure increase when the discharge is passed. The dissociation of diatomic gases in the high-frequency discharge was found to depend on the dimensions of the discharge chamber. An ordinary ozoniser tube, with the electrodes outside the glass, gave a very small dissociation, while cylindrical tubes with similar external electrodes at the ends gave values of over 50 % for the higher pressures. The dissociation was found to decrease with decrease in pressure. Air gave a higher dissociation for the same applied voltage and gas pressure than hydrogen. Chlorine was also shown to give at least a normal dissociation. AUTHORS.

1566. Disappearance of Hydrogen in Discharge Tubes. R. Delaplace. *Comptes Rendus,* 189. *pp.* 849–850, *Nov.* 18, 1929.

When a discharge is passed through a tube containing pure, dry hydrogen, no disappearance of hydrogen occurs and no traces of methane or oxides of carbon are formed. Spectroscopic examination of the discharge reveals only the secondary hydrogen spectrum. It is suggested that the disappearance of hydrogen observed in the undried gas is due to the formation of atomic hydrogen, which only occurs in the presence of water vapour. The recombination of the atomic hydrogen at points on the glass walls of the discharge tube causes intense local heating at these points with the liberation of traces of carbon monoxide and dioxide. The reduction of these gases to methane may then take place. F. J. W.

1567. Electrodeless Discharge. K. A. MacKinnon. *Phil. Mag.* 8. *pp.* 605–616, *Nov.*, 1929.

The electrodeless discharge in mercury vapour and iodine has been investigated in order to explain the apparently conflicting evidence obtained by Thomson and by Townsend and Donaldson. The results permit the conclusion to be drawn that with low excitations the discharge is electrostatic in origin, agreeing with the work of Townsend and Donaldson; while at higher excitations the bright ring discharge appears, which appears to be due to electromagnetic induction as postulated by Thomson. F. J. W.

1568. Flash in the Afterglow of the Electrodeless Discharge with Change of Pressure. C. T. Knipp and L. N. Scheuerman. *Phil. Mag.* 8. *pp.* 684–689, *Nov.*, 1929.

In examining the electrodeless discharge in gases, J. J. Thomson (*Phil. Mag.* 5. 32. pp. 321, 445, 1891) noticed a phosphorescent glow in certain gases and its absence in others, notably in individual gases, unless these formed polymeric modifications. Investigation of the flash appearing, under favourable conditions, in the afterglow on sudden compression of the glowing gas now shows that with air or oxygen this flash is noticeable over the whole range of pressures for which the afterglow is visible. With nitrogen the flash is obtainable at any time while the afterglow is visible, its brilliancy being proportioned to the brilliancy of the afterglow. At no time, in either of the three gases, was a flash formed after the disappearance of the afterglow. The results obtained, in conjunction with those of Newall [see Abstract 1323 (1898)], indicate that the alteration in phosphorescence due to change of pressure has two sources: (1) that described by Newall, in which the original grouping of the atoms or molecules is no longer stable and the gas passes into a new state of grouping with the evolution of energy, part of which would account for the pressure-glow and which persists for some time; (2) that now termed flash, the appearance of which is only momentary, accompanying a pressure pulse of the residual gas but not an expansion; this assumes the gas to be ionised and, granting that compression facilitates recombination, increased illumination results. These two types are shown with nitrogen, the former lasting many seconds and the latter for only a moment. T. H. P.

1569. Sparking Constants. Y. Satoh. *Ryojun Coll. Eng., Mem.* 2. *pp.* 154–204, *Aug.*, 1929. *In German.*

An experimental investigation of sparking constants was made by means of surge potentials. The results obtained show that the sparking constant is independent of the electrode shape so long as no pre-discharge in the form of corona, brushing or sparking occurs. If such discharges do occur the sparking constant is appreciably smaller. The sparking constant was also found to be independent of the capacity of the condensers employed, but increased with the wave resistance of the conductor over which the discharge passed. With increased sparking potential the sparking constant increases almost linearly. A. W.

1570. Spark Ignition of Gas Mixtures of Low Inflammability. K. Yumoto. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 318–321, *Oct.*, 1929. *In English.*

A study has been made of the ignition of gas mixtures of low inflammability obtained from air with 11–12 % or 82–84 % of carbon monoxide, or 3–4·5 % of ethyl bromide, using a long igniting spark. The sparks obtained were not uniform in structure, and further different portions of the spark were not equal in their ability to ignite the mixture. Ignition occurred most easily near the kathode, where the spark appeared to have a "splitted structure." F. J. W.

1571. Recombination of Gaseous Ions. L. B. Loeb. *Am. Electrochem. Soc., Trans.* 55. *pp.* 131–146; *Disc.*, 146–151, 1929.

It has been shown experimentally by Marshall, as well as theoretically by Sommerfeld and the writer, that the recombination process for gaseous ions is primarily a process of random drifting together of ions, the attractive forces playing a *rôle* only in the last free path or two between the ions. Owing to the non-random distribution of the ions in ionisation (ions generated in pairs close together), the value of α undergoes an apparently rapid decrease in the first 0·1 sec., and the value of α in short-time intervals depends both on the duration of the flash, the period of recombination, and the initial concentration of ions. The true value of the coefficient for air probably lies near $0{\cdot}9 \times 10^{-6}$, instead of $1{\cdot}6 \times 10^{-6}$ as usually assumed. Free electrons play no direct *rôle* in the recombination of ions as studied in gases near atmospheric pressure. The electrons can recombine with positive ions only by first attaching to molecules to form negative ions. The independence of α on the mobilities of ions is a direct consequence of the Thomson theory of a recombination due to thermal agitation, and depending largely on temperature and the unknown masses of the ions in most gases. AUTHOR.

1572. Ionising Action of Swift Electrons. H. Kulenkampff. *Phys. Zeits.* 30. *pp.* 777–780, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

Considers the recent very accurate measurements by Eisl of the total ionisation produced in air by electrons the velocity of which was determined accurately; also the work of Wisshak on the k ionisation produced in copper and other elements by similar electrons. The experimental curve of Wisshak gives values considerably lower than those shown in J. J. Thomson's theoretical curve, and the author considers that the difference between the two curves points to an influence of the atomic nucleus, and that this may be connected with the emission of continuous radiation. It may be supposed that under certain conditions the kathode-ray electrons may emit quanta of the continuous radiation, thus losing most of the energy, so that they are no longer able to produce k ionisation. The relation between the curves for elements of different atomic numbers seems to indicate the correctness of this view. H. N. A.

1573. Ionisation and Dissociation Processes in Simple Gases. H. Kallmann and B. Rosen. *Zeits. f. Physik*, 58. 1–2. *pp.* 52–58, 1929. *Phys. Zeits.* 30. *pp.* 772–773, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag, Prague, Sept.*, 1929.

In an investigation of the ionisation products of simple gases using the mass spectrograph, it is shown that previous measurements have yielded indefinite results owing to the failure to allow adequately for the interchange of charge between ions and neutral molecules. The present experiments show that in N_2, O_2, CO_2 and CO only primary ionisation products are found. In particular for CO_2 it is shown that besides CO_2^+, also CO^+ and C^+ arise as primary products. The method employed to elucidate the above points was to vary independently the gas pressures in the ionisation chamber and in the spectrograph respectively. W. S. S.

1574. Ranges of Ionising Electrons in Helium. T. H. Osgood. *Phys. Rev.* 34. *pp.* 1234–1238, *Nov.* 1, 1929.

The paper shows that a fourth power law for the absorption of ionising electrons in helium represents experimental results only for initial energies greater than 250 electron volts. For initial energies less than 200 electron volts, the formula $x = (a/c^2)[cE - f + f \log (cE - f)]$ is deduced, where x is the range of an electron of initial energy, E electron volts, and the remaining quantities are constants. The formula is in agreement with the available experimental evidence, and appears to be applicable, with suitable changes in the constants, to other gases. AUTHOR.

1575. Cylindrical Field in Ionised Air at Ordinary Pressure. Pauthenier and Mallard. *Comptes Rendus*, 189. *pp.* 843–845, *Nov.* 18, 1929.

In the theoretical study of the electric field in an ionised cylindrical space (axial wire at continuous negative high tension, cylinder joined to earth) the authors foresaw a notable modification of the field given by the ordinary electrostatic theory. Instead of the cylindrical field varying in inverse ratio of the distance from the axis there is a field high and almost constant in the region to which the calculation applies, *i.e.*, in the greater part of the annular space near the surrounding electrode. This paper gives an account of an experiment which verifies the results reached by calculation. The result leads to new points of view which may have practical consequences. [See also Abstract 1167 (1930).] J. J. S.

1576. Langmuir's Theory of Probes. R. Seeliger. *Phys. Zeits.* 30. *pp.* 527–531, *Sept.* 1, 1929.

Asks which quantities are to be regarded as independent variables in Langmuir's theory, and what part is played by the vapour pressure. Looks upon the kathode dark space as a degeneration of the probe dark space. E. E. F. d'A.

1577. Kathode-Ray Velocity. F. Kirchner. *Phys. Zeits.* 30. *pp.* 773–777, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

A description is given of a method of increased accuracy for determining the velocity of kathode rays. It is a modification of the old methods, and depends on the accurate measurement of the discharge potential and a new method of determining the ratio e/m. J. J. S.

1578. Current Distribution Near Edges of Discharge-Tube Kathodes. P. B. Moon and M. L. Oliphant. *Cambridge Phil. Soc., Proc.* 25, *pp.* 461–468, *Oct.*, 1929.

It has been observed that the disintegration by sputtering of a plane kathode in a gas discharge is not uniform but shows a maximum at a small distance from the edge. This phenomenon was examined experimentally by different methods and it is discussed in this paper. The chief object in view was to obtain further information concerning the part played by positive ions in the kathode mechanism of the glow discharge, and experiments are being continued. J. J. S.

1579. Charges of Mercury Atoms in Canal Rays. W. Jacobi. *Phys. Zeits.* 30. *pp.* 568–576, *Sept.* 15, 1929.

Using Thomson's parabola method with a stream of hydrogen containing a minute quantity of hydrogen vapour, the author found not only the hydrogen parabolæ and monovalent mercury parabola, but also three other parabolæ, which may be interpreted as due to mercury atoms carrying 7·9, 12 and 18·1 times the charge of the atoms giving the main parabola. An attempt to prove the presence of mercury direct was unsuccessful. E. E. F. d'A.

1580. New Studies of Canal Rays. H. R. v. Traubenberg. *Phys. Zeits.* 30. *pp.* 750–757; *Disc.*, 757–758, *Nov.* 1, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

A review of recent work on canal rays. F. J. W.

1581. Production of High-Speed Electrons by Indirect Means. E. T. S. Walton. *Cambridge Phil. Soc., Proc.* 25. *pp.* 469–481, *Oct.*, 1929.

Describes, with mathematical analysis, an attempt to procure high-speed electrons using an apparatus similar to that employed in electrodeless discharge work. The electrons were produced by a heated tungsten filament contained in an evacuated vessel around which was a coil connected to a condenser, spark gap and induction coil. A magnetic field parallel to the filament and at right angles to the coil was used to control the total field in which the electrons moved. Tests failed to show any radiations due to high-speed electrons. G. E. B.

1582. Irregularity of Movement of Electrons in Gases. R. Seeliger and T. Handt. *Ann. d. Physik,* 3. 5. *pp.* 575–584, *Nov.* 23, 1929.

Experiments have been made with hydrogen, neon, neon and air, neon and hydrogen, and air, in each case with some mercury vapour. The polarisation of the mercury line $\lambda = 4347$ was measured in different parts of the Geissler tube, and was found to be practically zero, except in the first kathode layer, where marked polarisation was found perpendicular to the surface of the kathode, that is, in the direction of the electric current. This is the direction of the electrical vector of the polarised light. The degree of polarisation varied from 0·16 to over 0·25 with different conditions of discharge and different gases in the tube; hydrogen gave the smallest polarisation and air the largest. The results are considered in the light of Quarder's work on the relation between the polarisation of the light produced by electronic collisions and the velocity of the electrons, and of Langmuir's theory that the discharge tube contains swift electrons and clouds of slow electrons in which the velocities may be distributed according to the Maxwell law, or in which one direction may be favoured to some extent. Certain conclusions are drawn as to the way in which the discharge takes place in different parts of the tube. H. N. A.

1583. Electron Waves. C. J. Davisson. *Frank. Inst., J.* 208. *pp.* 595–604, *Nov.*, 1929.

Description of experiments by Germer and the author demonstrating (*a*) that in the interaction between a metal and electrons there is involved a process similar to optical refraction, (*b*) that a stream of electrons is not polarised by reflection. A general account of the subject of electron waves to date is given and indications of the problems connected with it which are still unsolved. G. C. McV.

1584. Electron Scattering in Mercury Vapour. F. L. Arnot. *Roy. Soc., Proc.* 125. *pp.* 660–669, *Nov.* 1, 1929.

Deals with the angular scattering of electrons of about 80 volts energy in mercury vapour. The scattered electrons were caught by a Faraday cylinder the axis of which could be moved so as to make different angles with the electron beam. A retarding potential could be applied to the scattered beam, and the scattered electrons could be analysed into those elastically scattered, which retained their original velocity, those which when reflected by the mercury atom excited it to the resonance, or some higher level, and those which ionised the atom which scattered them. The electron ejected from the ionised atom should also be considered. The number of electrons scattered at an angle of θ decreases rapidly as θ increases; the elastic scattering curve falls off more rapidly than in helium for the same velocity of the primary beam. The inelastic scattering curve falls off more rapidly than the elastic one. The general characteristics of the results are in accord with those of Dymond and Watson for helium; the elastic scattering curve for mercury vapour deviates less violently from the inverse square law scattering curve than does the curve for helium; this implies that the outer field of the Hg atom resembles a Coulomb field far more closely than does that of the helium atom. H. N. A.

1585. Electron Scattering by Ionic Crystals. E. Rupp. *Ann. d. Physik,* 3. 4. *pp.* 497–506, *Nov.* 6, 1929.

The scattering of electrons by the simple ionic lattices of NaCl, KCl and KBr, has been investigated. A beam of electrons was allowed to impinge on a crystal at a definite angle and the influence of the velocity of the electrons on the intensity of the reflected beam studied. The results satisfied the simple Broglie equation, no modification for the refraction of the electronic waves being required. The refractive index $\mu = \sqrt{\frac{V + E_0}{V}}$, where V is the electronic voltage and E_0 is the inner lattice potential, is, within the limits of experimental error, equal to 1. For potassium chloride and bromide, E_0 must, therefore, be less than 1·50 volts. The experimental errors for sodium chloride are greater, and the upper limit for E_0 is put at 3 volts. Sodium chloride, further, differs from the others in that the sharpest maximum in the intensity of the reflected beam occurs at 32 volts for an angle of incidence of 30°. This maximum is without explanation, for it appears to bear no relation to the lattice parameters. F. J. W.

1586. Measurement of Polarisation of Electron Rays. J. Lass. *Ann. d. Physik,* 3. 5. *pp.* 701–720, *Nov.* 23, 1929.

Prefaced by a short historical survey of the work of other observers, the author proceeds to a description of the methods of investigation, and points out that two courses are open for the determination of the polarisation in a change in velocity of the emitted electrons. The electrons pass from a Wehnelt's kathode in the usual way through a strong electric field, following which they are exposed to an opposing field, finally passing into a neutral zone, in which the observations are made; but to observe the course of the polarisation of the rays by the speed of the emitted electrons one must also endeavour to get the various speeds constant. The circuit diagram is given and illustrations of the apparatus and optical arrangements are shown with full details of their construction and use. It appears from the observations and photometric measurements made that the amount of polarisation varies in a very similar manner to the intensity (demonstrated by graphs). J. G. H. B.

1587. Emission of Electrons from Metals Covered by Thin Films in Intense Electric Fields. T. E. Stern. *Cambridge Phil. Soc., Proc.* 25. *pp.* 454–460, *Oct.*, 1929.

Fowler, Gosling and Stern have recently shown that it is necessary to extend the original Fowler–Nordheim theory of the auto-electronic discharge, in which electrons are extracted from cold metallic kathodes by intense electric fields; it is necessary to take into account the effect of any films on the kathode. If such films have a lower thermionic work function χ than the clean metal of the kathode the electron emission is greatly increased. In the present paper the emission formula is derived for the case where the electrons must penetrate a thin superficial layer having a lower χ. By assigning values to the thickness of the film which are extremely probable, it is possible to make the formula agree with the observed data. The thickness of the most stable films of sodium on tungsten is found in this way to be about $2 \cdot 5 \times 10^{-8}$ cm. H. N. A.

1588. Positive Emission from Palladium. M. Wolfke and J. Rolinski. *Phys. Zeits.* 30. *pp.* 817–818, *Nov.* 15, 1929. *Paper read before the Deut. Physikertag., Prague, Sept.*, 1929.

The emission from palladium wire and strip was studied in a vacuum, the temperature of the wire being raised to 1100°–1200° C. In all cases a strong initial (fresh) emission was obtained. The mass of the ions was ascertained by deflection in a magnetic field, the ions being probably alkali. After removal of the initial emission, activation of the palladium by various means was attempted, but failed in all cases. Pure hydrogen was also passed through a narrow palladium tube heated to 1200° C., but no emission was obtained. Hence, the authors believe that the emission obtained by Richardson in the case of platinum was due to insufficient preliminary heating to get rid of the initial emission. T. B.

1589. Richardson Kathode Constant. W. Espe. *Zeits. f. techn. Physik,* 10. 11. *pp.* 489–495, 1929. *Paper read before the Deut. Phys. u. Math., Prague,* 1929.

An investigation into the Richardson–Laue law for thermionic emission, $i_s = AOT^2\epsilon^{-B/T}$, where i_s is saturation current, O the surface area of the kathode, T the absolute temperature and B a constant depending on the kathode material, with special reference to more complex kathodes, such as a cæsium film on tungsten or BaO paste. G. E. B.

1590. Phenomena in Oxide-Coated Filaments. J. A. Becker. *Phys. Rev.* 34. *pp.* 1323–1351, *Nov.* 15, 1929.

A theory of the activity changes in these filaments is put forward, based on the comparison of the properties of these and other filaments with composite surfaces. It appears probable that the oxide-coated filaments owe their high activity to adsorbed metallic barium, and the changes in emission are ascribed to electrolysis of the oxide. The theory was tested experimentally by accurately measuring the relative rates of evaporation of small amounts of electropositive and electronegative materials, by allowing the evaporated barium or oxygen to be deposited on one side of a flat tungsten ribbon whose thermionic activity is followed. If it is assumed that the optimum condition is attained when the ribbon is covered with a single layer of material, these relative rates can be converted to absolute rates. The following facts came to light as the result of the experiments made: (*a*) Metallic barium evaporates provided the temperature is not too high and that no appreciable currents are drawn, whereas oxygen evaporates if a limited current is drawn and the temperature is high enough. (*b*) Barium deposited on the surface of the oxide produces similar changes in activity to those due to deposition of barium on tungtsen. (*c*) Oxygen brought to the surface by drawing current from the filament may increase or decrease the activity according to circumstances. (*d*) It appears that the conductivity of the oxide does not conform to Ohm's Law. The complex time changes are described systematically. J. G. H. B.

1591. Effect of Ultra-Violet Light on the Thermionic Current from Oxide-Coated Metal Foil. E. Bodemann. *Ann. d. Physik*, 3. 5. *pp*. 614–628, *Nov*. 23, 1929.

The current is generally increased, being greater than the sum of the photoelectric and thermionic currents. The additional current vanishes when the voltage applied is sufficient for saturation. It may also be greatly reduced by " out-gassing " the foil. Pure metal, in the absence of an oxide coating, gives evidence of showing the same phenomena, but to a very much smaller extent. The effect is attributed to a space charge of electrons at the metal surface. J. H. A.

1592. Sensitising Process in Potassium Photoelectric Cells. N. Campbell. *Phys. Zeits*. 30. *pp*. 537–538, *Sept*. 1, 1929.

Maintains that two distinct changes accompany sensitisation. One consists of a change in the coarser surface structure, shown in a change of colour, which, however, cannot be proved to be due to an evaporation of potassium. The other change consists in the formation or, less probably, the elimination of a monatomic sheet of gas. E. E. F. d'A.

1593. Photoelectric Cells. L. R. Koller. *J.O.S.A. and R.S.I.* 19. *pp*. 135–145, *Sept*., 1929.

A summary of the properties of some photoelectric cells and their chief applications. E. E. F. d'A.

1594. Selenium Cells and Photo Cells. F. Schröter and W. Ilberg. *Phys. Zeits*. 30. *pp*. 801–804, *Nov*. 15, 1929.

A comparison is made between selenium cells and photo cells, and their behaviour on illumination is discussed. If a definite connection between illumination and internal resistance is assumed, then for the selenium cell $dE_g/dL = E/L \times 0\cdot125$ where dE_g is the change of the tension of the reinforcement valve, E the tension of the battery in the cell circuit and L the illumination. For the photo cell the dependence of the cell resistance on the illumination and the tension of the cell is expressed by $dE_g/dL = E/L \times 0\cdot172$. J. J. S.

1595. Photoelectric Thresholds of the Alkali Metals. N. R. Campbell. *Phil. Mag*. 8. *pp*. 667–668, *Nov*., 1929.

The author gives some evidence for thinking that the conclusion of Ives and Olpin [see Abstract 315 (1930)], that the photoelectric thresholds of thin films of the alkali metals are identical with the resonance potentials of their neutral atoms, does not hold when the surface carrying the thin film is not a gas-free metal surface. W. S. S.

1596. Analysis of Triode Valve Rectification. Part II. S. E. A. Landale. *Cambridge Phil. Soc., Proc.* 25. *pp.* 482–490, *Oct.*, 1929.

Continuation of a previous paper [see Abstract 3149 (1929)], and almost entirely mathematical. G. E. B.

1597. Supposed Effect of X-Rays on Crystal Rectifiers. S. Oberto. *Accad. Lincei, Atti.* 10. *pp.* 89–92, *July*, 1929.

Referring to Jackson's experiments with crystal detectors [see Abstract 3148 (1929)], the author describes the action of the "Cuprox" rectifier. Here the rectification takes place between surfaces and not between a single point and a plane. On exciting the X-ray tube an increase of current takes place in the rectifier. In determining the characteristic it was found that: (1) the characteristic with the currents used did not become symmetrical with respect to the origin and always kept the rectification; (2) the effect produced by the discharges diminishes gradually with time as long as an eventual thermal effect is excluded; (3) the return to initial conditions never takes place completely, the limiting characteristic after prolonged repose corresponds to conditions of rectification less favourable than those at first preceding the discharge. As to the supposed effect of X-rays, the author considers that correction should be made for the influence of the electrostatic discharges occurring in the tube. J. J. S.

1598. Electric Spectrum of Water in Region λ3 Metres. N. Novosilzew. *Ann. d. Physik*, 2. 5. *pp.* 515–536, *Aug.* 15, 1929.

Apparatus is described which allows the investigation of spectra in the wave-length region 4–2 metres, using undamped waves. The accuracy claimed is 0·15 %. In particular, water is investigated between 3 and 2·2 m., and the absence of any anomalous dispersion in this range of wave-lengths is proved. A. C. M.

1599. Production of *n*-Phase High-Frequency Currents. F. Tank and L. Ackermann. *Helv. Phys. Acta*, 2. 7. *pp.* 512–521, 1929. *In German.*

Describes an arrangement for producing polyphase high-frequency currents by connecting two or more oscillators to suitable points in an oscillatory system. G. E. B.

1600. Form of the Resonance Curves for Standing Electrical Waves in Wires. R. King. *Ann. d. Physik*, 3. 7. *pp.* 934–936, 1929. *Rev. Sci. Instruments*, 1. *pp.* 164–180, *March*, 1930.

Refers to a recent paper by Kessenich [see Abstract 326 (1930)]. The author in this experiment uses a wire, or rather tube system, which can be varied continuously in length from 1 to 14 m.; the inductively coupled indicator is replaced by one coupled by means of capacities, which can be adjusted for any frequency, so that the characteristic vibrations of the wire system are not affected. The generator, or oscillator, is quite similar to the wire system, but shorter; the two circuits can be coupled as loosely as required, and the generator is movable freely over the whole length of the wire. Perfectly symmetrical resonance curves can be obtained by properly adjusting the indicator coupling, and the length of the wire system, for each wave-length, making the resonance curves completely symmetrical over the whole length of the system. A series of curves is given showing the results obtained. H. N. A.

1601. Magnetic Susceptibility of Oxygen as a Function of Temperature and Density. H. R. Woltjer, C. W. Coppoolse and E. C. Wiersma. *K. Akad. Amsterdam, Proc.* 32. 10. *pp.* 1329–1333, 1929. *Comm. No.* 201A *from the Phys. Lab., Leiden.*

Measurements have been made at temperatures varying from about 285° K to 155° K, with different densities. The specific magnetic susceptibility of the gas cannot be represented by the formula $\chi(T + \Delta) =$ constant (where Δ depends on the density), as was the case in the experiments of Perrier and Kamerlingh for liquid oxygen diluted to different concentrations with liquid nitrogen. From 291° to about 175° K Curie's law is nearly followed with a Curie constant (and so an atomic moment), depending on the denisty, $\chi T = C$, where $10^2C = 2\cdot86$ for $\rho = 0\cdot443$ and $3\cdot15$ for $\rho = 0\cdot00$; thus, the atomic moment of oxygen depends on the density. There is, however, a slight but systematic curvature of the $1/\chi$, T lines, which becomes marked below 175° K. H. N. A.

1602. Magnetic Moment of the Oxygen Atom. O. E. Kurt and T. E. Phipps. *Phys. Rev.* 34. *pp.* 1357–1366, *Nov.* 15, 1929.

The magnetic moment of the oxygen atom has been investigated by the atomic ray method of Stern and Gerlach. The atomic oxygen was formed by means of an electrodeless ring discharge and the ray was detected by its oxidising action on freshly sublimed litharge. When the ray was passed through an inhomogeneous magnetic field the resulting image consisted of an undeviated central line and two broad lines displaced symmetrically, one on each side. Hydrogen was substituted for oxygen and the procedure was repeated. The separations obtained in the two cases provided the data necessary for the calculation of the effective magnetic moment of the oxygen atom. The experimental magneton values were zero and ± 1·67. The magneton numbers expected from the spectroscopic ground term of oxygen are 0, ± 3/2 and ± 3. The effective magneton numbers which (due to overlapping of the images) would result from these values are zero and ± 1·71. The agreement is within the limits of experimental error. AUTHORS.

1603. Constant Paramagnetism of Pentavalent Vanadium Ion. N. Perrakis. *Am. Electrochem. Soc., Trans.* 55. *pp.* 79–83, 1929.

The paramagnetic susceptibility of the pentavalent vanadium ion was investigated and found to be independent of the temperature. Two grades of V_2O_5 were tested, and also the salts NH_4VO_3 and $NaVO_3$. Both the ascension and attraction methods were employed. An average value of 44×10^{-6} correct within 10 % was found for the susceptibility of V^v. This value is appreciably lower than the value Honda and Owen obtained for metallic vanadium, but since this difference cannot be ascribed to errors in experimentation, it seems safe to conclude that the constant paramagnetism, like the atomic moment, may have several different values for the same atom. The importance and need of further study of this important subject are emphasised. AUTHOR.

1604. Magnetic Moments of the Complex Ions of the Iron Group. P. Weiss. *Am. Electrochem. Soc., Trans.* 55. *pp.* 75–78, 1929.

The magnetic moments of the *simple* ions of the iron group, with minor exceptions, depend only on the number of electrons in the ion, in accordance with Kossel's displacement law, and as shown by Cabrera's curve. For *complex* ions an "effective" atomic number N′ must be used, which is defined by the equation $N' = N - v + 2i - 2p$, in which N is the total number of electrons in the central atom, v the valence, i the coordination index and p the number of pairs of electrons in the outer shell; p is generally 4 (rare gas configuration), but in some cases the influence of the subjacent M shell may cause p to become 6, in which cases the coordination index will be 6 also. This leads to a generalisation of Kossel's law: "The magnetic moment of a complex ion is equal to that of the normal ion of the same valence, or to that of a normal ion whose effective atomic number is greater by 4." AUTHOR.

1605. Different Magnetic States of an Ion. G. Foex. *Am. Electrochem. Soc., Trans.* 55. *pp.* 97–103, 1929.

The magnetic moment of the atoms or of the ions of a paramagnetic substance has generally one predominating value for each ion, but at times different values may occur. The ferrous ion has been found to exist in three distinct magnetic states, and it is difficult to account for the differences between them. Measurements made with different samples of $NiSO_4$, either as solid or in solution, have always given the value of 16 magnetons. The cobalt ion value is 25 magnetons. The dehydrated dry $CoSO_4$ gave a value of 26, and when put into solution gave a value of 26, but after long standing the value decreased to 25 magnetons. However, when a cobalt salt ($CoCl_2$) is put into solution in alcohol the value for the cobalt ion is only 23 magnetons, although upon crystallising the salt out of this solution we obtain the value of 26. In concentrated sulphuric acid the value is 25·66. It follows that the ion in solution is not always the same as the ion in the crystal. It seems probable that the different magnetic states correspond to a different structure in the outer layer of electrons in the atom. It is to be expected that other properties of the ion which depend on that outer layer will change with the changes which occur in this layer. AUTHOR.

1606. Measurement of Magnetic Quantities. L. W. McKeehan. *J.O.S.A. and R.S.I.* 19. *pp.* 213–242, *Oct.*, 1929.

An epitome of the principles and methods employed in the measurement of B, H, I, μ and k. The methods are described under the headings: (*a*) Ponderomotive forces: (1) on currents; (2) on magnets. (*b*) Electromotive Forces: (1) in fixed coils; (2) in moving coils; (3) in alternating fields. (*c*) Secondary effects: (1) on conduction of electricity; (2) on propagation of light. Reference to the original work is aided throughout by an appended Bibliography containing over two hundred entries. G. E. A.

1607. Magnetic Properties of Manganese Compounds. L. F. Bates. *Phil. Mag.* 8. *pp.* 714–732, *Nov.*, 1929.

Gives the results of a study of the magnetic properties of phosphide and arsenide of manganese at temperatures above their magnetic critical points, where both substances are strongly paramagnetic. With the arsenide, the susceptibility is practically constant over a range of temperature from 90° to 130° C., after which the Weiss law is obeyed. The nature of the temperature hysteresis exhibited by this compound is discussed and an explanation based on the presence of loosely-bound particles of arsenic is put forward. In the case of the phosphide the Weiss law is approximately obeyed. C. O. B.

1608. Magnetisation of Nickel-Cobalt to Saturation, and the Atomic Moments of Nickel and Cobalt. P. Weiss, R. Forrer and F. Birch. *Comptes Rendus,* 189. *pp.* 789–791, *Nov.* 12, 1929.

Nine nickel-cobalts were tested up to saturation at ordinary temperature, and that of liquid air as with the series of ferrocobalts [see Abstract 1193 (1930)]. The curve of absolute saturation, expressed in magnetons per atom divided by 1125·6, is composed of two straight lines. The first portion extends from $n = 3$ for Ni and tends towards $n = 9$ for Co; the second part deviates at about 66 % Ni, and ends at $n = 8·5$ for Co. In the γ alloys the moment of Co varies according as it is alloyed with iron or with nickel. Other differences are stated. G. E. A.

1609. Magnetostriction of Single Crystals of Cobalt. Z. Nishiyama. *Tôhoku Univ., Sci. Reports,* 18. *pp.* 341–357, *Oct.,* 1929. *In English. Report No* 224 *from the Research Inst. for Iron, Steel and other Metals.*

The magnetic change of length in single crystals of cobalt has been observed, the specimens being those which have been prepared by S. Kaya [see Abstract 2833 (1929)]. Specimens of polycrystals have also been used for comparison. In the direction of the axis of the hexagonal lattice—that is, of easy magnetisation—the longitudinal and transverse effects are a small contraction. When the magnetic field is applied in the direction perpendicular to the axis—that is, in the direction of difficult magnetisation—the longitudinal effect is negative, and the transverse effect in the basal plane is also negative, but that in the direction of the axis positive. The amount of these effects is large as compared with that observed in the case where the magnetic field is applied in the direction of the axis of the hexagonal lattice. When the field is applied in an intermediate direction on the prism surface, the magnetostriction is rather larger than that in the principal directions. AUTHOR.

1610. Equivalence of a Mechanically Oscillated Electrostatic Charge to an Alternating Current. R. C. Tolman and D. B. McRae. *Phys. Rev.* 34. *pp.* 1075–1105, *Oct.* 15, 1929.

A charged cylinder was arranged to oscillate around its axis at frequencies of about 20 cycles per sec. through an amplitude of over 180°. It was surrounded by an " effect coil " having 260,772 turns of fine wire. The result of the investigation showed that a mechanically oscillated electrostatic charge of electricity surrounds itself with an alternating magnetic field, accompanied at right angles by an alternating electric field capable of producing an alternating e.m.f. in a suitably placed secondary. Further, it was shown that at right angles to both the magnetic and electric fields there must be a Poynting-vector field corresponding to the observed transmission of energy to the secondary, and that these quantities all have the magnitude and time dependence predicted by electromagnetic theory. J. J. S.

1611. Heat Evolution during Magnetisation of Steels. K. Honda, J. Ôkubo and T. Hirone. *Tôhoku Univ. Sci. Reports,* 18. *pp.* 409–417, 1929. *In English.*

Two of the present authors in a previous paper discussed in detail the blem of hysteresis, and calculated the energy dissipated at every step of the magnetisation. From these data they deduced the Warburg-Ewing's Law that the total loss of energy during a complete cycle of magnetisation is equal to the area enclosed by the hysteresis loop in the magnetisation-field curve. It is noted that this theory ignores the thermal motion of the molecules, and is applicable, therefore, only to the case where thermal disturbance is negligibly small. The present work is undertaken to test the validity of the authors' molecular theory of magnetisation with regard to the heat developed during magnetisation. Experimental details are appended. It is shown that the net energy of magnetisation is less than 50 % of the total energy, and, hence, a greater part of the applied energy is dissipated. The dissipated energy nearly coincides with the energy thermally observed, thus vindicating the theory. It is further concluded that in the theory of ferromagnetism, the irreversible process plays an important part, and, therefore, any theory of ferromagnetism which ignores this consideration, such as those of Weiss and Heisenberg, fails to explain important phenomena, and is unsatisfactory. S. G. B.

1612. Longitudinal Solutions of the Heisenberg-Pauli Electromagnetic Equations. L. Rosenfeld. *Zeits. f. Physik,* 58. 7–8. *pp.* 540–555, 1929.

The solutions, corresponding to longitudinal vibrations, of the Heisenberg–Pauli modified Maxwell's equations are obtained directly without the use of the idea of " perturbed " empty-space radiation adopted by Heisenberg and Pauli [see Abstract 3262 (1929)]. These solutions are applied to the calculation of the electrical interaction energy of radiation and matter, and of the probabilities of transitions. Finally, the connection between this work and the new quantum electrodynamics of Heisenberg–Pauli (which do not employ the parameter ϵ) is discussed. G. C. McV.

1613. Classical and Modern Electromagnetic Theories. A. Press. *Phil. Mag.* 8. *pp.* 637–658, *Nov.*, 1929.

It is shown that if the classical theory is employed, taking account of the two Fresnel types of etheric media, one condensed after the manner of Stokes' near atomic nuclei, and forming the atomic diameters, the other being the normal ether between atoms, practically complete reconciliation can be obtained with the results of Einstein's restricted relativity theory. The mathematics of the problem is worked out in detail, and the question of the Michelson–Morley experiment in an optically dense medium is dealt with. The residual effect of Miller appears to be fully accounted for.
H. N. A.

1614. Electric Current Measurement in Terms of Length, Mass and Time. T. B. Brown. *J.O.S.A. and R.S.I.* 19. *pp.* 320–325, *Nov.*, 1929.

The experiment consists of two parts: In Part I the magnetic field produced by an electric current flowing in a modified Helmholtz coil is balanced against the field of a permanent bar magnet. In Part II this same magnet is swung at the centre of the coil as a magnetic pendulum. From these observations, made in terms of length, mass and time *only*, both the strength of the current and the magnetic moment of the magnet may be computed. Inaccuracy due to an unsteady local " earth's field " is minimised, and a relatively high precision results. AUTHOR.

APPARATUS AND INSTRUMENTS.

1615. Cylindrical Electrostatic Machine. D. F. Luscia. *Pont. Accad. Sci., N. Lincei, Atti.* 82. *pp.* 399–407, 1928–1929. *Supplement.*

Attention is called to the electrostatic machines with cylinders the mode of action of which can throw light on the theory of those of other forms. A new type of cylindrical machine is described which is characterised by a new form of diametrical conductor. Its advantages are explained and particular phenomena are discussed in relation to general electrostatic theory. J. J. S.

1616. Sensitivity of Electrometers. E. Perucca. *Accad. Lincei, Atti*, 10. *pp.* 92–96, *July*, 1929.

The behaviour of different forms of electrometer is discussed, and formulæ are worked out as a result of a schematic theory. J. J. S.

1617. Further Development of New Recording Kathode-Ray Oscillograph. P. Selényi. *Zeits. f. techn. Physik*, 10. 11. *pp.* 486–489, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

The paper supplies details of development in the apparatus described earlier (see Abstract 1671 (1929)]. In this state the tube acts as well as the classical Braun tube, for the curves are immediately fixed. This new form is also based on electrostatic deviations, the deviating condenser being in the form of two metal plates on the inner surface of the tube. Some results following from the use of the method and observations on its method of working are given. R. S. R.

1618. Metallic Resistances of 10^{10} to 10^{11} Ohms. E. Perucca. *Comptes Rendus*, 189. *pp.* 527–529, *Oct.* 7, 1929.

A new application of Bronson's method of measuring a very small current passing through a very high resistance. The realisation of a constant resistance of from 10^{10} to 10^{11} ohms was very difficult, but was obtained by metallic films of platinum and gold by kathodic projection on threads of glass and quartz. The author then gives the results of his studies of their electric resistance, and claims that a constant metallic resistance from 10^{10} to 10^{11} ohms with practically no temperature coefficient is now an accomplished fact. A thread electrometer is preferable to the quadrant type for taking measurements, and one evolved by the author has been used in this connection. Currents up to 10^{-14} ampere can be measured. [See Abstract 1698 (1928).] T. C. H.

1619. High Ohmic L.T. and H.T. Resistances. F. Krüger. *Zeits. f. techn. Physik*, 10. 11. *pp.* 495–500, 1929. *Paper read before the Deut. Phys. u. Math., Prague*, 1929.

A description is given of high resistances—from about 10^6 to 10^{12} ohms—formed of powdered metals on highly insulating surfaces. J. J. S.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

1620. Evolution of the X-Ray Pastille Dose in Röntgen (*r*) Units. G. W. C. Kaye and W. Binks. *Brit. J. of Radiology*, 2. *pp.* 553–575; *Disc.*, 575–578, *Dec.*, 1929.

A calibration in *r* units has been made of the B dose indicated by barium-platinocyanide pastilles irradiated by unfiltered X-rays from a Coolidge tube excited by voltages between 50 and 100 kV from an induction coil. A provisional ionisation standard based on an electroscope had previously been set up. It was then found that I . *t* (where I is the ionisation per unit time and *t* the time for a pastille B dose) was constant for 70 kV. The work has now been extended over a range from 50–100 kV, and the I.*t* of the electroscope is found to increase with increasing kilovoltage. A standard ionisation chamber has been designed and constructed, and by its aid the I.*t* readings of the electroscope in question are expressed in *r* units. The results show that the readings of the electroscope are selective as regards wave-length. The essential dimensions of the standard ionisation chamber have been examined experimentally and found to be not so large as those contemplated as necessary by earlier workers. The most troublesome factor entering into the measurement of the *r* unit is the volume of air irradiated. The present results show that this is best represented by the frustrum of a cone, of length equal to that of the collecting electrode of the standard chamber, the cross-sectional dimensions being obtained from the images of the X-ray beam or photographic films placed in turn at each end of the collecting electrode: the effective focal distance of the frustrum is measured to the centre of the collecting electrode. The alternative "cylinder" method of evaluating the volume leads in the present work to discrepant and substantially higher results (some 90 *r* larger) for the value of the pastille dose. As the exciting voltage on the X-ray tube is increased, the value of the pastille dose falls from about 380 *r* at 50 kV to 330 *r* at 100 kV. W. V. M.

1621. Ultra-Violet Solar Radiation and Solarisation of Window Materials. W. W. Coblentz and R. Stair. *Bureau of Standards, J. of Research*, 3. *pp*. 629–689, *Nov*., 1929.

This paper deals with three fundamental questions. (*a*) The amount of ultra-violet in solar radiation of wave-lengths less than about 310 $m\mu$, found to be of especial use in preventing rickets, but shut out by common window glass. (*b*) The decrease in transmission that occurs in the new window glasses developed for transmitting ultra-violet of wave-length less than 310 $m\mu$ when exposed to ultra-violet radiation. (*c*) The proper use of windows in order to obtain the most effective therapeutic results. (*a*) Data were obtained by four methods relating to the first question, showing that the upper limit of the total radiation is less than 0·3 % of the total incident solar rays, or less than 0·004 gm. cal./cm.^{2}/min., diminishing to an imperceptible value at sunrise and during cloudy weather. (*b*) Nearly all the newly-developed window glasses decrease in transmission, especially in the region less than 310 $m\mu$, when exposed to the sun and to artificial sources containing ultra-violet radiation. Glasses of 2·3 mm. thickness were tested as to their transmissive properties at 302 $m\mu$ after solarisation. Common window glass and quartzalite gave a transmission of less than 1 %; Vita glass, Sanalux and Renovic about 25 %; Holviglass, Sunlit and Sendlinger's ultra-violet glass, 35–40 %; Helioglass, Uviol-Jena and Neuglass, 45–50 %; Corex-D glass, 60–65 %; Corex-G glass 981FF^2; and quartz glass, 80–90 %. (*c*) Data are given showing that with variation of the angle of incidence of the solar rays from normal on the solarium, during the year and during the day, the amount transmitted through the glass decreases by about 20 %. Dust and dirt reduce the transmission at 302 $m\mu$ by 30 to 40 %. Double thickness (6 mm.) wired glass is not recommended owing to its very low transmission properties after solarisation. Hence, a glass of single thickness (2·5 mm.), with a wire mesh under it for safety from breakage, is recommended for solarium roofs.

W. C. S. P.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

1622. Adsorbed Atoms and Ions. J. A. Becker. *Am. Electrochem. Soc., Trans.* 55. *pp.* 153–173; *Disc.*, 173–175, 1929.

Adsorbed particles may exist on the surface either as positive adions (adsorbed ions) negative adions or adatoms. Whether a given substance will be adsorbed as an atom, a positive ion, or a negative ion, will depend on the fields of force that exist near the metal surface, and near the particle at their distance of nearest approach. The ratio of adions to adatoms can be determined from thermionic experiments. The adsorbed ions produce electrical fields, which extend to ten or more atom diameters; which close to the surface may attain enormous values, and which appreciably alter the electron work function and the evaporation energy for atoms and ions. The ratio of ions to atoms that evaporate from one and the same surface is determined by the electron work function of the surface and the ionisation potential of the adsorbed particles. Within a certain range of temperature, the adsorbed particles migrate over the surface like a two-dimensional gas. Adatoms and adions have vastly different chemical properties from ordinary atoms. The length of time that an atom remains on the surface before evaporation is determined. AUTHOR.

1623. Adsorption of Oxygen and Ozone by Silicic Acid Gel. A. Magnus and K. Grähling. *Zeits. f. phys. Chem.* 145. *Abt. A.* 1. *pp.* 27–47, *Nov.*, 1929.

A series of measurements of the adsorption of oxygen and ozone by silica gel at 204·0 to 224·4° Abs. was made. The pressures ranged from 100 mm. to 760 mm. The adsorption isothermals of a mixture of oxygen and ozone were determined over the same range of temperature, and at pressures of 0 to 34 mm. The heat of adsorption, calculated from the results of the determinations, was 3200 cal. for oxygen, and 5600 cal. for ozone. The temperature coefficient of the heat of adsorption was − 30 cal./degree for oxygen and − 175 cal./degree for ozone. The decomposition of ozone adsorbed by silica gel was measured in a differential ozonometer. The reaction was shown to be a monomolecular reaction, and diffusion was an important factor in the reaction. F. J. B.

1624. Adsorption of an Admixed Gas from an Air Stream. N. Schilow, L. Lepin and S. Wosnessensky. *Kolloid Zeits.* 49. *pp.* 288–296, *Nov.*, 1929.

A stream of air containing a known quantity of chlorine passes at a controlled velocity along a tube containing the adsorbent carbon, divided into separate lengths, between which are interposed arrangements for detecting and estimating the chlorine at those points without interruption of the main stream. The distributions of the adsorbed chlorine in the carbon stratum, and of the unadsorbed chlorine in the gas phase over the length of carbon, are determined for various forms of carbon and different rates of flow. From the results it is shown that the properties of an adsorbent stratum under specified conditions can be defined on the basis of two experimentally determined quantities. The "dead space" of Mecklenburg's theory [see Abstract 394 (1926)] is given a definite physical meaning.

Practical applications to processes of filtration and extraction are indicated. A. J. M.

1625. Desorption of Electrolytes in the Coagulation of Suspended Particles. S. Wosnessensky, W. Lasarew and T. Perewersewa. *Kolloid. Zeits.* 49. *pp.* 296–301, *Nov.*, 1929.

Measurements of electrical conductivity show that the coagulation of an aqueous suspension of kaolin which occurs on progressive addition of an electrolyte is accompanied by an abrupt increase in the concentration of electrolyte in the dispersion medium. The phenomenon is to be attributed to desorption of the electrolyte on coagulation of the suspended particles. Hydrochloric acid and calcium chloride are desorbed from kaolin suspensions to a greater extent than are aluminium chloride and sulphate, on account of the hydrolysis of the aluminium salts, giving rise to adsorbable positive aluminium hydrate. Examples of the effects of desorption are given in connection with sewage effluents, and also with the technology of viscose manufacture. A. J. M.

1626. Heat of Dilution of Hydrochloric Acid, Sodium Hydroxide and Acetic Acid. R. C. Payn and E. P. Perman. *Faraday Soc., Trans.* 25. *pp.* 599–610, *Nov.*, 1929.

The experiments described were on the heats of dilution of the three substances in solution in water, but it was also found possible to observe the heat of dilution of water in acetic acid by means of a slight modification of the method. The precautions taken to avoid heat losses are outlined and the results of the various experiments are fully tabulated. Concentration limits were made as wide as possible, and observations were made at six different temperatures ranging from 20° to 70° C. Hydrochloric acid solutions give a series of curves lying close together, and exhibit no unusual characteristics, whilst the curves given by sodium hydroxide closely resemble them, except that the two lowest give small positive heats in dilute solutions. In the case of acetic acid the curves show large positive values at the higher concentrations and small negative heats in the more dilute solutions, and it is found that for any particular concentration the heat of dilution is a linear function of the temperature. The heat of dilution of water in acetic acid was examined for one temperature and the results were used to calculate the heat of dilution of acetic acid in water, and it is found that the calculated and observed results agree quite satisfactorily. To prevent the possibility of interaction with the glass vessels when examining sodium hydroxide, these were lined with thin, pure silver sheaths. [See also Abstract 1464 (1927).] J. G. H. B.

1627. Viscosity and Elasticity of Sols. B. Rabinowitsch. *Zeits. f. phys. Chem.* 145. *Abt. A.* 1. *pp.* 1–26, *Nov.*, 1929.

The properties of ideal, viscous and elastic liquids are derived systematically from their relation to shear, and an apparatus is described with which the velocity of flow of highly viscous liquids forced through capillaries may be measured in relation to the pressure and to the length and cross-section of the capillary. Measurements made in this way on acetyl cellulose, nitrocellulose and rubber solutions reveal divergencies from Poiseuille's law, with which, however, other substances agree. A generalisation of Newton's viscosity theory is proposed, in which the velocity gradient is a function of the shearing stress. This generalisation is confirmed experimentally with both purely viscous and elastic liquids. All the results obtained may be represented by the two-constant formula $Q/R^3 = A\tau_R + B\tau_R^2$, where Q is the rate of flow, τ the shearing stress, R the radius of the tube, and A and B constants. By means of this formula the whole of the tenacity properties of a liquid within the limits of laminar stationary flow are characterised by the two constants A and B.

T. H. P.

1628. Permeability of Hot Metals to Hydrogen. B. C. Hendricks and R. R. Ralston. *Am. Chem. Soc., J.* 51. *pp.* 3278–3285, *Nov.*, 1929.

Zinc is permeable to hydrogen between 305° C. and its melting point. Pure copper is permeable above 500° C. Within the limits of error the diffusion of gases through metals is best related by $D = KP^{\frac{1}{2}}T^{\frac{1}{2}}e^{-q/4T}$. The heat of dissociation of hydrogen in nickel is about 21 kg. cal. A. A. D.

1629. Fibre Texture in Nickel Wires. G. Greenwood. *Zeits. f. Krist.* 72. 3. *pp.* 309–317, *Nov.*, 1929. *In English.*

Nickel wire cold-drawn from soft wire of 1·7 mm. diameter to 0·33 mm. shows distinctly a fibrous structure. X-ray photographs on wire drawn down to 0·26 mm. diameter show that the fibrous structure of cold-drawn nickel resembles that of other face-centred cubic metals, the particles arranging themselves so that the [111] and [100] directions are parallel to the fibre axis. It differs from iron in which the [110] becomes parallel to the direction of drawing. The displacement of the spots in the X-ray photograph in the direction of drawing shows that the fibre texture is not of the simple parallel type, but has a conical formation. By using soft radiation, giving reflections only from the surface, and etching away the surface layers, the nature of the fibre texture at different depths in the wire is studied. The relative intensities of the spots produced by the two sets of particles show that more particles are arranged with the [111] direction parallel to the fibre axis than with the [100] direction parallel to it. The side of the unit cube is found by Kettmann's method to be $a = 3{\cdot}515 \pm 0{\cdot}002$ Å. **Erratum,** *ibid.*, 73. 3–4. p. 442, March, 1930.

A. J. M.

1630. Crystal Structure of Manganese. S. Sekito. *Zeits. f. Krist.* 72. 4. *pp.* 406–415, *Nov.*, 1929. *In English.*

Previous work by Westgren and Phragmén, and by Bradley, had led to the conclusion that the existence of three modifications of manganese was probable. A careful determination of the space lattices of manganese confirmed this conclusion, and the temperature range over which the three modifications were stable was determined. It was found that α-manganese was stable up to 800° C., β-manganese from about 800° to 1100° C. and the γ-manganese above 1100° C. The tetragonal manganese, obtained by electrolysis, was the modification which was stable at the highest temperature range. Copper in solid solution in manganese caused the axial ratio of the γ-manganese to increase, with the copper content, until it became unity. F. J. B.

1631. X-Ray Examination of Copper Amalgam. N. Katoh. *Zeits. f. phys. Chem.* 6. *Abt. B.* 1. *pp.* 27–39, *Nov.*, 1929.

The solid phase in the mercury rich amalgams has a γ structure with a lattice constant $a = 9{\cdot}401$ Å. The solid phase obtained by pressing such an amalgam has the same structure and lattice constant. The limit of the γ phase lies at about 29 % of copper. The copper rich amalgams consist of two phases, *i.e.*, an a phase (copper lattice) and a γ phase. A. A. D.

1632. Nickel-Copper Alloys at Low Temperatures. A. Krupkowski and W. J. de Haas. *K. Akad. Amsterdam, Proc.* 32. 7. *pp.* 912–920, *and* 921–929, 1929. *Comm. Nos.* 194A *and* 194B *from the Phys. Lab., Leiden.*

The following properties of a series of alloys have been examined down to the temperature of liquid hydrogen, (*a*) electrical resistance, (*b*) thermoelectric force against copper, (*c*) thermal expansion, (*d*) magnetic transition temperature. With less than 43 % of nickel there is no ferromagnetic phase, even at the lowest temperatures. The other properties cited generally show abnormal behaviour in the magnetic transformation region. A. A. D.

1633. Equilibrium Diagram of the Copper-Tin-Antimony System. M. Tasaki. *Kyoto Coll. Sci., Mem.* 12. *pp.* 227–255, *Sept.*, 1929. *In German.*

Certain ranges of the Cu-Sn system (Cu 60 % to 80 %) and the Sn-Sb system (Sb 40 % to 60 %) were examined initially, and certain modifications of the accepted diagrams are suggested. In the ternary system γ and δ phases of the Cu-Sn system build ternary solid solution with γ and δ pf the Cu-Sb system. The ϵ phase of Cu-Sn gives a ternary compound with Sb. A. A. D.

1634. Structure of Silver-Antimony Alloys. M. G. Raeder. *Zeits. f. phys. Chem.* 6. *Abt. B.* 1. *pp.* 40–42, *Nov.*, 1929.

Certain new phases have recently been found in this system by X-ray analysis. The writer points out that he arrived at the same conclusion previously on the basis of overvoltage measurements. A. A. D.

1635. Graphitisation of Cast Irons. A. Portevin and P. Chévenard. *Comptes Rendus*, 189. *pp.* 759–761, *Nov.* 4, 1929.

The known factors governing the graphitisation of cast iron during annealing are specified, and a new factor suggested, *viz.*, the fineness of the structure before annealing. It is shown that the finer the initial structure the more complete is the breakdown of the cementite. A. A. D.

1636. Solid Solution of Iron in Graphite. S. Konobejewski. *Zeits. f. Krist.* 72. 4. *pp.* 381–397, *Nov.*, 1929.

A substance was obtained by heating iron with graphite, which had a similar structure to certain naturally occurring samples of graphite. The structure was investigated by means of X-ray analysis, and it was found that iron has been introduced into the space lattice of graphite. The probable position of the iron atom was determined. It was thought that the iron atom formed iron carbide, FeC, by combination with the carbon atoms inside the space lattice of the graphite. The production of the solid solution of iron in graphite was found to be accompanied by a small change in the constants of the graphite lattice, and the change was calculated from the experimental data. F. J. B.

1637. Passivity of Metals. Part III. Quantity and Distribution of the Superficial Oxide. U. R. Evans and J. Stockdale. *Chem. Soc., J. pp.* 2651–2660, *Nov.*, 1929.

A method for the removal of the surface skins of metals, which depends upon anodic undermining, and transferring the metallic skin to a film of nitrocellulose lacquer, is worked out. Films were removed from several fresh materials, such as nickel and carbon steel, and a transparent film was isolated from stainless steel. The oxide on heat-tinted nickel appeared to be sharply divided from the metal, while on copper and iron there was interlocking. Determinations of the oxides per unit area were made. It was found that the difficulty of film removal varied enormously in different cases. It was greatest, as a rule, when the film was very thin and highly protective. F. J. B.

1638. Iron and Nitric Acid. Z. C. Mutaftschiew. *Zeits. f. Elektrochem.* 35. *pp.* 861–862, *Nov.*, 1929.

The behaviour of iron and nitric acid was investigated. The iron was obtained by reduction of pure FeO in hydrogen, and pure iron powder was purchased from Kahlbaum. The amount of iron dissolved in nitric acid of specific gravity 1·2, 1·42, and 1·39 was determined, and it was found that the results were reproducible with 1·42 and 1·39 acid. The time of contact varied from five minutes to twenty-one hours. A weak magnetic field, about 140 gauss, was without influence on the rate of solution in 1·39 and 1·42 acid. When 1·2 acid was used, the rate of solution became almost explosive in violence. F. J. B.

1639. Pseudo-Components of Hydrogen. Parts II and III. A. Smits. *K. Akad. Amsterdam, Proc.* 32. 7. *pp.* 951–960, *and* 32. 8. *pp.* 1118–1123, 1929. *Phys. Zeits.* 31. *pp.* 172–180, *Feb.* 15, 1930.

These papers continue previous work [see Abstract 3247 (1929)], and also discuss contemporary results by Bonhoeffer and Harteck, and Eucken and Clusius with Hiller. In Part II it is shown that the internal equilibrium between the two molecular species α and β in the fundamental states α_0 and β_1 may be calculated for different temperatures from the formula $\log K_{Gr} = -\frac{Q}{RT} + C$, or from the Boltmann equation $N_{\beta_1}/N_{\alpha_0} = p_{\beta_1}e^{-Q/RT}/p_{\alpha_0}$, when Beutler's value of 329 cal. is adopted for Q, and also the statistically obtained $C = 2\cdot196$. The maximum value of $(K_{Gr})_{T=\infty}$ then becomes 9. In Part III the values of Part II are modified by taking into consideration different states of rotation whose relationships alter with the temperature. H. H. Ho.

1640. Calorimetric Determination of the Energy Difference between the Two Modifications of Hydrogen. G. v. Elbe and F. Simon. *Zeits. f. phys. Chem.* 5. *Abt. B.* 2. *pp.* 79–87, *Nov.*, 1929.

Measurements are described and recorded for the heats of transformation of the equilibria of mixtures of para- and ortho-hydrogen at 20° and 78° Abs., obtained as differences of adsorption and desorption with active carbon. The experimental values are in agreement with theory.

H. H. Ho.

1641. Studies on Inflammability of Hydrogen. Y. Tanaka and Y. Nagai. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 418–429, 1929. *In English.*

The apparatus is that used in the research of Nagai and Furihata [see Abstract 209 (1928)]. Ethyl bromide, tetramethyl-tin, diethylselenide, or benzene being added to a mixture of 10 or 20 % of H_2 with air, the energy required to ignite the mixture increases up to a certain point with an increasing amount of these substances, then becomes constant, and finally increases very rapidly. With a concentration of 30 or 40 % of H_2 the effect is somewhat the same, but with no horizontal part in the curves. The first increase in the energy is attributed to the rising of the theoretical flame-propagation temperature due to the addition of the substances. The final rapid increase in the energy is due to the getting near to the upper limit of inflammability. It is shown that if a small amount of tetramethyl-tin is added to these mixtures, the minimum concentration of H_2 required to enable the mixtures to " self-sustain " the flame on a burner generally increases at first a little, and then decreases. The first increase is due to the rising of the theoretical flame-propagation temperature, and the decrease is due to the heat of combustion of the added substances. Propagation of the flame is prevented by placing copper gauzes of various mesh in different parts of a long glass tube 27 mm. in diameter, in which, at the open end, the mixtures are fired. It is found that the extinction of the flame propagated in the H_2-air mixtures becomes far easier if the explosion-suppressors, such as tetramethyl-tin, benzene, etc., are added to the mixtures in small amounts. Tables and curves are given. T. B.

1642. Investigation of the Formation of Molecular from Atomic Hydrogen. H. Senftleben and O. Riechemeier. *Phys. Zeits.* 30. *p.* 745–750, *Nov.* 1, 1929.

In the investigation now described, disturbances due to surface effects of the reaction vessel, purity of gas, etc., have been avoided as far as possible, and a quantitative method is obtained for measuring the velocity of formation of molecular from atomic hydrogen. Very full experimental details are included. H. H. Ho.

1643. Photochemical Combination of Hydrogen and Chlorine at Low Pressures. A Trifonoff. *Zeits. f. phys. Chem.* 6. *Abt. B.* 2. *pp.* 118–126, *Nov.*, 1929.

In the earlier paper [see Abstract 3025 (1929)] the reaction of $H_2 + Cl_2$ at pressures $p = 0{\cdot}1$ to $0{\cdot}8$ mm. Hg for equimolecular mixtures was investigated. For pressures $p > 0{\cdot}2$ mm. the rule $W/p^3 = K$ is satisfactory, where W is the velocity of the reaction. For pressures $P < 0{\cdot}2$ the reaction is a far slower and follows a quite different rule. The dampness of the gases does not appear to influence the limits found. The author was unable to show definitely that the grease with which the tap is coated is without influence on the reactions. J. K.

1644. Photochemical Reactions of Ergosterol. E. H. Reerink and A. van Wijk. *K. Akad. Amsterdam, Proc.* 32. 7. *pp.* 845–848, 1929.

A solution of ergosterol in hexane is irradiated while contained in an evacuated quartz vessel. The progress of the photochemical reaction is followed by means of observations of the absorption spectrum of the liquid. On irradiation by light of wave-length between 300 $\mu\mu$ and 270 $\mu\mu$, about 60 % of the ergosterol can be converted into vitamin D, without the formation of byproducts, but it is impossible to obtain a yield greater than 15 % by the use of light of wave-length 254 $\mu\mu$, and in this case the formation of byproducts cannot be prevented. Vitamin D is obtained as lozenge-shaped transparent plates melting below 0° C. A. J. M.

1645. Repulsion of Atomic Kernels as a Factor in Organic Rearrangements. W. M. Latimer. *Am. Chem. Soc., J.* 51. *pp.* 3185–3190, *Nov.*, 1929.

A survey was made of twenty instances of molecular rearrangements and their repulsion energies between their kernels. These rearrangements involved instances of increase, decrease and no change in the repulsion energies. The results showed that: (1) the great majority of these changes took place with a decrease in the inter-kernel repulsion energy; (2) a few occur with no change in repulsion energy; (3) rearrangements with an increase in repulsion energy are rare, and are invariably accompanied by a complex redistribution of electrons in the molecule. The results are in accord with the following premise: If there are a number of possible arrangements of the atoms in a molecule which have the same number of electrons per atom, and which satisfy equally well the tendencies of the more electronegative elements to complete their octets of electrons, that form will be the most stable which gives a minimum of repulsion between the atomic kernels. F. J. B.

1646. Transition from Non-Polar to Polar Linkage. R. Samuel and L. Lorenz. *Zeits. f. Physik,* 59. 1–2. *pp.* 53–82, 1929.

In this investigation it is shown how far the transition from non-polar to polar linkage depends in regular fashion upon two factors, *viz.*, the ionisation voltage of the positive partner of a molecule, and the electronic affinity, the latter being assisted by additional forces such as heat of solvation, mutual interaction of ions and dipoles, etc. The limits for the change in the mode of union alter with the external conditions. Consideration is given to the different states of aggregation, solutions, the so-called pseudo-electrolytes, the relationship of acids and bases, and the different acids with like central atoms. H. H. Ho.

1647. Reactions of Dissociated Water Vapour. H. C. Urey and G. I. Lavin. *Am. Chem. Soc., J.* 51. *pp.* 3290–3293, *Nov.*, 1929.

Water vapour, when dissociated in a discharge tube, gives reactions which are characteristic of atomic hydrogen, and from the results it is concluded that atomic hydrogen is present in the active gas. Water vapour seems to be more active than atomic hydrogen, in that it will reduce metallic salts which are not reduced with atomic hydrogen. Active gas is prepared from water vapour with greater ease than from hydrogen, and it has been indicated that there is another active constituent, probably the OH molecules, present in the active gas. H. H. Ho.

1648. Production of Hydroxyl by Water-Vapour Discharge. G. I. Lavin and F. B. Stewart. *Nat. Acad. Sci., Proc.* 15. *pp.* 829–832, *Nov.*, 1929.

The investigation was undertaken with a view to furthering the determination as to whether the presence of the bands at 3064 Å., known as "water bands," is due to the neutral hydroxyl group or to the hydroxyl ion. The apparatus used (which is practically identical with that used by Urey and Lavin [see preceding Abstract] in preparing atomic hydrogen from water vapour) is described and illustrated together with an account of the procedure adopted. From the data obtained it would appear that the greater the intensity of the hydroxyl bands, the greater the quantity of hydrogen peroxide produced, and further, that the production of the peroxide is due to the interaction of two hydroxyls or some other reaction in which one stage is the formation of excited hydroxyl groups. J. G. H. B.

1649. Visible Afterglow of Active Nitrogen. G. Cario and J. Kaplan. *Zeits. f. Physik,* 58. 11–12. *pp.* 769–780, 1929.

Investigation of the spectrum of the afterglow and of the effect of variations of temperature shows that the bands of the first positive group observed in the afterglow are emitted by nitrogen molecules, present in active nitrogen in the metastable state ($A_0 = 8\cdot 2$ volts), which are excited to the B_{12} and B_6 levels by collision of the second kind with metastable nitrogen atoms at the ^2P ($3\cdot 56$ volts) and ^2D ($2\cdot 37$ volts) levels. These metastable states are constantly re-established at the expense of the energy which is set free in the recombination of nitrogen atoms to form molecules. A. J. M.

1650. Method of Formation of Precipitates. J. Wulff. *Zeits. f. phys. Chem.* 6. *Abt. B.* 1. *pp.* 43–61, *Nov.*, 1929.

From tests of precipitation of iodine upon different surfaces it is concluded that: (*a*) *in vacuo*—(1) the crystallisation occurs primarily at curved surfaces, (2) the orientation of the initial crystals is at first independent of the surface but later depends upon the kind of crystal formed, (3) the layer increases with the curvature in glass capillaries, and (4) with silvered tubes and rods the rate of deposition increases with curvature; (*b*) for molecular radiation—(1) the initial deposit occurs primarily in crevices and places of strain, (2) the crystal whose main direction of increase is opposite to the radiation occurs most frequently, (3) for given radiation the precipitation increases in the order—cover glass, quartz crystal, rough cover glass, lined quartz, lined Jena glass, split rock-salt surface and condensed rock-salt surfaces, this order depending upon surface and capillary space, (4) depth of deposit on a silver plate increases with the amount of cold working and curvature, (5) depth of deposit for convex and concave glass surfaces increases with the curvature and size of surface exposed to radiation, but the additional action of tension produced by polishing cannot be excluded. R. S. R.

1651. Reactions in Solids. J. Hume and J. Colvin. *Phil. Mag.* 8. *pp.* 589–596, *Nov.*, 1929.

In this paper an investigation is made of the importance of various factors in reactions of the types, solid → solid and solid → solid + gas or liquid. Such reactions, which consist essentially of the transformation of a metastable crystal lattice into one more stable, are characterised by the initiation of reaction at certain points where the formation of an element of the new lattice serves as a nucleus from which the decomposition spreads, the most probable positions of which are surface points where deformation has occurred. By observation of the transformation of monoclinic into rhombic sulphur and of the dehydration of potassium hydrogen oxalate hemihydrate, this view has been completely confirmed. The three factors governing the course of the reaction have been studied in detail, *viz.*, rate of nucleus formation, linear rate of propagation and size of the reactant particles. Full experimental results are included, with data and reaction curve. H. H. Ho.

1652. Propagation of Detonation Across a Gas-Gap between Two Cartridges of Explosive. G. S. J. Perrott and D. B. Gawthrop. *Frank. Inst., J.* 208. *pp.* 643–660, *Nov.*, 1929.

The sensitivity of a mining explosive to detonation is usually expressed in terms of the distance across which detonation will propagate from one cartridge to another separated from it by an air gap. Data on this question were given in a previous article [see Abstract 1812 (1927)]. In the present paper the same experimental procedure as before is followed, but with either air, hydrogen or CO_2, or, in a few cases, helium, in the gap between the two cartridges. Velocities are measured with the Mettegang recorder, and a photographic method previously described [see Abstract 1461 (1927)] was employed to check the results. The greatest velocity is found in gases of low density (H or He), and in these cases the initial velocity in the gap is greater than in the explosive itself, and this velocity increases over the first 30 cm. of the gap. The length of air gap over which detonation will propagate is increased more than ten-fold if the system is enclosed in a steel tube. It is concluded from the relative speeds of the disturbance in H_2, air and CO_2 that this disturbance is a discontinuous wave phenomenon of high intensity, *i.e.*, a shock wave. Tables and diagrams are given for various explosives, indicating the velocity of the propagation of the disturbance at various distances from the end of the initiating cartridge. In general, this velocity increases to a maximum at distances of 10 to 40 cm., and then decreases. T. B.

1653. Source of Potential: Metal-Solution. A. E. Brodsky. *Phys. Zeits.* 30. *pp.* 665–669, *Oct.* 15, 1929.

The theory of Debye and Hückel is employed to develop thermodynamically a division of the electrode potential into the sum of two factors. One factor depends upon the nature of the electrode, and the other on the properties of the solution. With the help of the theory a substitute is obtained for the second term, which is in complete agreement with earlier approximate calculations. This leads to a linear relationship with the dielectric constant of the solvent. F. J. B.

1654. Variation with Temperature of Contact E.M.F. J. J. McHenry. *Phil. Mag.* 8. *pp.* 474–491, *Oct.*, 1929.

In a previous paper [see Abstract 2185 (1927)] experiments were described which suggested that the contact p.d. between clean metals was proportional to the absolute temperature. In the present paper the changes with temperature of the voltaic character of aluminium, zinc and copper are described, the metal surfaces being in dry air at atmospheric pressure. For a slow rise of temperature of 1° C., aluminium and zinc become more electropositive by 0·0047 and 0·003 volt respectively. Copper, on the other hand, becomes more electronegative by 0·007 volt/degree. The changes with temperature of the voltaic character of the metals are not instantaneous, but take several hours to be complete. It is found that $dE/dT > E/T$, where E is the contact p.d. between a pair of the metals and T the absolute temperature. Taking the maximum values of dE/dT, it is found that they are roughly 40 or 50 % higher than the values of E/T. Experiments are also described with metal surfaces under liquid paraffin in which the condenser method was used, but it was found that the ageing or tarnishing of the metal surfaces takes place under the oil just as readily as in air, and no conclusion could be arrived at as to whether the changes of the p.d. observed with changes of temperature were due to the removal of surface impurities or not. H. H. Ho.

1655. Silver Chloride Electrode. W. R. Carmody. *Am. Chem. Soc., J.* 51. *pp.* 2901–2904, *Oct.*, 1929.

A study of the factors that affect the potential of the silver chloride electrode has been made. Directions are given for its preparation and care while being used. Results show that the silver-silver chloride electrode deposited electrolytically, when carefully prepared and used, is quite as reproducible and constant as the hydrogen electrode. AUTHOR.

1656. E.M.F. of Silver-Silver Chloride-Calomel Cells. W. M. Mazee. *Am. Electrochem. Soc., Trans.* 55. *pp.* 349–356, 1929.

The conditions of preparing silver-silver chloride electrodes reproducible within 0·1 mV have been studied. The potentials found have been 42·2, 44·2, 44·4 and 46·6 mV at 25° C. The value of 46·6 mV is considered as the real silver-silver chloride potential, because the silver metal used corresponds to the most electropositive, therefore, the most stable silver, and the silver chloride used is the least soluble form. The value, 46·6 mV, is a confirmation of the value found by some of the previous investigators whose results were not in entire agreement.

AUTHOR.

1657. Antimony Electrodes for the Differential Titration of Aqueous and Alcoholic Solutions. I. I. Shukoff and V. M. Gortikoff. *Zeits. f. Elektrochem.* 35. *pp.* 853–860, *Sept.*, 1929.

It was shown previously by Shukoff and Awsejewitsch that antimony electrodes could be used for the differential titration of acids and bases, and that the use of such electrodes had advantages over platinum electrodes. The advantages of the use of antimony electrodes are investigated further, and it is found that the addition of quinone or phenolphthalein to the titrated solutions is unnecessary. The potential of the antimony electrode is shown to be defined by the hydrogen-ion concentration, and consequently gives more definite results than the quinone electrode. The differential titration method makes it possible to detect small changes which take place during the titration. For example, the presence of small quantities of carbonate in the sodium hydrate solution, or derived from the air, can be detected. The antimony electrodes are shown to be applicable to the titration of carbonate solutions, without the removal of the CO_2, and also to the titration of alcoholic solutions. F. J. B.

1658. Lead Electrode. W. R. Carmody. *Am. Chem. Soc., J.* 51. *pp.* 2905–2909, *Oct.*, 1929.

A new method of e.m.f. measurement in dilute solutions is described. E.M.F. measurements have been made on the cell Pb(Hg), $PbCl_2$, AgCl, Ag. From the results of these measurements the normal electrode potential of lead and the activity coefficients of lead chloride have been calculated.

AUTHOR.

1659. Amount of Hydrogen and Oxygen Present on the Surface of a Metallic Electrode. F. P. Bowden. *Roy. Soc., Proc.* 125. *pp.* 446–462, *Oct.* 1, 1929.

The potential changes occurring at metallic electrodes in a dilute acid electrolyte on the passage of definite quantities of electricity were investigated. With a bright platinum electrode the quantity of electricity required to change the potential from that of H to that of O, or *vice versa*, is 9×10^{-4} coulomb per sq. cm., *i.e.*, 9×10^{-9} gm. ions per sq. cm. With rapid deposition, to avoid loss by natural decay, this quantity is independent of the current density and the direction of the change, and is in agreement with that calculated on the assumption that the potential change from that of O to H involves the removal of an oxygen adsorbed on or between each accessible metal atom on the surface and its replacement by hydrogen. The quantities necessary to cause further changes in the electrode potential and establish the H and O overpotentials were found to be considerably smaller. The adsorbed oxygens and hydrogens seem to be distorted by the forces at the metal surface with the formation of orientated dipoles, whose number and electric moment control the p.d. across the interface. There is evidence for the formation of a layer of platinum oxide on a platinum anode on which oxygen is being deposited. The formation and reduction of a unimolecular layer of platinum oxide on a platinum surface produces little change in its accessible area, but causes a marked increase in its catalytic activity. J. J. S.

1660. Rôle of Atmospheric Oxygen in Photovoltaic Cells with Coloured Liquids. A. Grumbach and S. Schlivitch. *Comptes Rendus*, 189. *pp*. 753–754, *Nov*. 4, 1929.

The influence of atmospheric air on the e.m.f. of photovoltaic cells was investigated. The e.m.f. of the same cell was determined at atmospheric pressure, and *in vacuo*. The solution employed was the sodium salt of fluorescein dissolved in water or glycerin. The solutions were exposed to the light from a mercury arc. At atmospheric pressure the Becquerel effect was negative, and the effect of mass was positive. *In vacuo*, both e.m.f.s were negative and were greater in absolute magnitude. F. J. B.

1661. Influence of the Electrolyte on the Potential of Inversion of the Photovoltaic Effect. R. Audubert. *Comptes Rendus*, 189. *pp*. 800–802, *Nov*. 12, 1929.

The existence of an inversion potential in the photovoltaic effect was shown to depend on the polarisation of the electrode by exposure to light. The value of the inversion potential was found to depend upon the nature of the metal of the electrode and upon the electrolyte. The effects of a number of different electrolytes on the potential were determined. The potential of inversion was independent of the concentration of the electrolytes. In the case of gold and platinum a difference between the potentials of inversion in all the electrolytes studied, amounting to 203×10^{-3} volts, was found to exist. This difference was probably due to the different electrochemical properties of the two metals. F. J. B.

1662. Phase Limits of "Ideal" Electrodes. B. Kamienski. *Zeits. f. phys. Chem*. 145. *Abt. A*. 1. *pp*. 48–56, *Nov*., 1929.

Carborundum crystals of different colour, selected from commercial material, were used as electrodes. It was shown that the purer the material the more constant was the potential of the electrode. Bright green transparent crystals gave a practically constant potential, independent of the changes of the electrolyte. Such an electrode was considered as ideal. A platinum electrode was considered as a not ideal unattacked electrode. The best example of the ideal physical phase limit is that of electrolytic solution/saturated air. The difference of the dielectric constants of the phases and the thermal movement of ions and dipoles, as well as the changes of free energy at the surface, was considered as sufficient cause for electrical polarisation. F. J. B.

1663. Becquerel Effect. Part II. C. Winther. *Zeits. f. phys. Chem*. 145. *Abt. A*. 2. *pp*. 81–96, *Nov*., 1929.

The behaviour of the copper oxide electrode was studied. It behaved as an irreversible electrode and required a continual supply of oxygen. When the electrode was exposed to radiation the copper oxide became electrically conducting, and the inner and outer layers of the electrode formed an oxygen concentration element, owing to the difference on oxygen concentration in these two layers. In this way the low potential of the copper electrode was raised. The change was the Becquerel effect. Artificial Becquerel electrodes were made. An element was made of quinhydrone and a copper electrode, which was connected to a selenium cell. Exposure to radiation increased the potential of the copper electrode and reduced the potential of the quinhydrone electrode. This behaviour was considered as an instance of positive and negative Becquerel effect. [See also Abstract 1097 (1928).] F. J. B.

1664. *p*H Measurement with the Glass Electrode and Vacuum Tube Potentiometer. L. W. Elder, Jr. *Am. Chem. Soc., J.* 51. *pp.* 3266–3272, *Nov.*, 1929.

The vacuum tube potentiometer previously described by Elder and Wright [see Abstract 1723 (1929)] is modified so as to increase its sensitivity and simplicity. Comparative measurements on the vacuum tube potentiometer and Lindemann electrometer show that the apparent potentials of high resistance glass cells measured on the former instrument include a free grid potential which is constant over the *p*H range from 0 to 10, and directly proportional to the glass cell resistances. Data are given for a number of brands of soft glasses in a series of buffers previously standardised by the hydrogen electrode. The asymmetry potentials of electrodes of the bulb type measured in N hydrochloric acid are constant for any one glass stock, and vary among different stocks from 5 mV. to 64 mV. The effect of anodic polarisation by 110 V. for 15 to 20 hours disappears completely after three days. Kathodic polarisation under the same conditions produces a polarisation potential of 40 to 50 mV. after three days, which persists for a further six days. Annealing for 15 to 20 hours at 120° C. causes a decrease in potential which is variable and very slow in disappearing. The asymmetry potentials of electrodes prepared by the method of MacInnes and Dole are uniformly low, irrespective of the glass used. Methods are suggested whereby the data presented can be used for *p*H measurement by the glass electrode without employing standard buffers. A. J. M.

1665. Table of Electrochemical Equivalents Based on 1929 Atomic Weights. G. A. Roush. *Am. Electrochem. Soc., Trans.* 55. *pp.* 383–393, 1929.

1666. Electrochemistry of the Mercurous Ion. A. E. Brodsky. *Zeits. f. Elektrochem.* 35. *pp.* 833–837, *Nov.*, 1929.

The results of determinations of the activity coefficients f of aqueous mercurous nitrate solutions by means of e.m.f. measurements at four different temperatures [see Abstract 1679 (1926)] show that the dependence of these coefficients on concentration and temperature is in agreement with Debye's limit law in so far as $\log f$ is proportional to the square root of the concentration c. The factor of $\log f$ is, however, $\sqrt{2}$ times as great as the value derived from Debye's theory. The normal potential $2Hg \rightarrow Hg_2^{\cdot\cdot}$ with reference to the normal hydrogen electrode at 18° is calculated to be $+ 0{\cdot}803$ volt. The solubility products previously obtained for the mercurous halides are calculated more accurately and calculations are made of the solubility products of a number of mercurous salts. T. H. P.

1667. Electrocapillary Curves for Thallium Amalgams. J. Eisenbrand. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 463–475, *Nov.*, 1929.

According to the phase rule, a homogeneous system of two or more components has one degree of freedom; any one of its properties will vary continuously, within limits, as any external factor (*e.g.*, applied potential, in the present case) is varied. The curves which result, for mixtures of different compositions, will possess a common point of intersection if only two components are present. Applying this principle to the data of Frumkin and Gorodetzkaja [see Abstract 341 (1929)] for the surface tensions of amalgams containing 1·03–41·5 % of thallium, the author shows this to be the case, within the limits of experimental error, for 75 % of the data. The small deviations in the remaining 25 % are attributable to adsorption effects. Reasons are adduced for supposing the second component to be thallium itself, and not a compound (*e.g.* $TlHg_2$ or Tl_2Hg_5) as sometimes supposed. L. V. C.

1668. Electro-Stenolysis and Electrolytic Processes at Membranes. K. Söllner. *Zeits. f. Elektrochem.* 35. *pp.* 789–799, *Oct.*, 1929.

The metallic separations formed at certain membranes, precipitates and porous diaphragms on passage of a current are of two kinds: (1) Those appearing with only very low active potentials (2–3 volts). Such are always formed if the substances at which the separation occurs are electron-conductors like oxides and sulphides of the heavy metals. To this class belongs the electrocapillary Becquerel phenomenon, which was explained by Freundlich and Söllner [see Abstract 1729 (1929)], and depends on the formation of short closed galvanic elements. (2) Those named electro-stenolysis and observed when a porous wall, in contact on both sides with a solution of a suitable metallic salt, is traversed by a current. Separation of metal takes place when the potential exceeds a certain limiting value, which is usually at least 20 volts and often considerably higher. This is not a capillary-electric phenomenon, since it is largely independent of the electrokinetic potential. Electro-stenolysis may be readily explained on the assumption of ionisations occurring in consequence of the high potentials and falls of potential. The phenomena are, indeed, analogous to those which have been investigated at certain electrodes, especially such as are employed as electrolytic rectifiers. T. H. P.

1669. Theory of Electroosmosis. S. Komagata. *Chem. Soc. Japan, Bull.* 4. *pp.* 255–264, *Nov.*, 1929. *In English.*

The theory of electroosmosis is discussed mathematically, and the distribution of the potential and electric charge in the capillary is calculated. An equation is derived for calculating the quantity of liquid which flows out electroosmotically. The relation between permeability of the membrane and electroosmotic transfer is shown to be different from that given by Helmholtz. F. J. B.

1670. Movement of Liquid Streams and Droplets in an Electric Field. E. H. Büchner and A. H. H. van Royen. *Kolloid Zeits.* 49. *pp.* 249–253, *Nov.*, 1929.

Humphrey [see Abstract 1229 (1927)] observed that a stream of colloid sol falling between two parallel vertical electrodes was deflected on applying an electric field, and attributed the phenomenon to cataphoresis. In certain cases the stream was broadened to a fan-shape. The authors show that Humphrey's explanation is untenable, since the effect is instantly visible to the naked eye on applying the field, and since it may be observed in non-colloidal solutions, *viz.*, in solutions of inorganic electrolytes. Other experiments described show that the broadening or contraction of liquid streams and the distortion of droplets of liquid suspended in a second liquid between a pair of electrodes is quite general, and depends upon a difference in conductivity between the two liquids. Differences in dielectric constant do not completely explain the phenomena. Application of an electric field results in the formation of charges on the interface between the liquids, and the stream or droplet is distorted by the electrostatic forces acting upon these charges. If the conductivities are equal, no effect is observed. This theory is confirmed experimentally by checking the equal-conductivity criterion for the absence of the effect, and by studying the rate of broadening as a function of the applied field. L. V. C.

1671. Rôle of Membranes in Electrodialysis. R. Bradfield and Hannah S. Bradfield. *J. Phys. Chem.* 33. *pp.* 1724–1732, *Nov.*, 1929.

Experiments were made on the effects of a protein coating on the permeability of collodion for anions. The membranes were prepared by evaporating a solution of collodion, and then soaking it in a solution of haemoglobin. The anode of an electrolytic cell was contained in this membrane, a parchment membrane surrounding the kathode. The properly prepared membranes soaked in certain proteid solutions were much more permeable to anions than the untreated collodion or parchment commonly used in electrodialysis. Membranes covered with protein did not possess a valve-like action, but were positively charged when used next to the anode, and negatively charged when used next to the kathode, except in cases of very high or very low *p*H values. It was found that the course of the electrodialysis was complicated by the action of the colloid being purified. F. J. B.

1672. Individuality of the Heat of Dilution of Strong Electrolytes. E. Lange and J. Meixner. *Phys. Zeits.* 30. *pp.* 670–678, *Oct.*, 15, 1929.

The Debye–Hückel theory of strong electrolytes and the integral heat of dilution and activity coefficients are mathematically discussed. The methods for the approximate calculation of the integral heat of dilution and their derivation are considered. A method for the calculation of the exact heat of dilution was developed, taking into account the higher factors. The theoretical results were compared with those obtained experimentally. At lower concentrations the agreement between theory and experiment was better than had been previously found. F. J. B.

1673. Heats of Dissociation of Strong Electrolytes in Benzonitrile. Their Calculation from Molecular Structure. A. R. Martin. *Phil. Mag.* 8. *pp.* 547–552, *Oct.*, 1929.

The dissociation constants, *k*, of various alkali halides and of silver nitrate in benzonitrile are calculated from the conductivities previously published [see Abstract 1387 (1929)], together with the dielectric constant. The heats of dissociation derived therefrom compare well with those theoretically obtained (for NaI and KI) when the dissociation is analysed into the following three stages: (1) removal of undissociated molecule (a dipole) from solvent to air or *vacuo* (author), (2) dissociation of molecule *in vacuo* (Born and Heisenberg) and (3) solvation of the ions (Born). L. V. C.

1674. Freezing-Point Measurements in Very Dilute Solutions of Strong Electrolytes in Cyclohexanol. E. Schreiner, O. E. Frivold and F. Ender. *Phil. Mag.* 8. *pp.* 669–680, *Nov.*, 1929.

The previous results with uni-univalent salts in cyclohexanol [see Abstract 815 (1927)] showed the great influence of the electrical properties of the solvent on the osmotic behaviour of a solution. The measurements have now been extended to uni-bivalent and uni-trivalent salts in the same solvent, as the influence of greater charges should be stronger than with uni-univalent salts. The freezing-point constant in cyclohexanol is found to be 38·2 ± 0·1. The curves connecting $(1 - g)$ with $\sqrt{\nu\gamma}$, especially for mixture of salts, do not correspond with the tangents calculated theoretically, as was the case with the uni-univalent salts, at very low concentrations. The results obtained with the uni-bivalent uranyl acetate do not, however, appear to conflict with the theory. Discrepancies remain to be explained, but it seems established that, the greater the valencies of the dissolved ions and the less the dielectric constant of the solvent, the greater the deviations to be expected from the original Debye-Hückel theory. T. H. P.

1675. Conductivity of Uni-Univalent Salts in Cyclohexanol. O. E. Frivold. *Frank. Inst., J.* 208. *pp.* 627–642, *Nov.*, 1929.

Results are given of conductivity measurements on solutions of lithium chloride, bromide and perchlorate and guanidine nitrate in cyclohexanol at concentrations between 0·00001 and 0·001 mol. per litre, the equivalent conductivity being found by extrapolation. The temperature coefficient of the specific conductivity of lithium chloride has been determined at two concentrations and the viscosity of cyclohexanol at various temperatures. Kohlrausch's law of linearity between the equivalent conductivity and the square root of the concentration does not hold for the three lithium salts, but it seems to hold for guanidine nitrate at very low concentrations. That more of the lithium salts do not obey this relation or obey it only at exceptionally high dilutions has been observed with other non-aqueous solvents, and the peculiar behaviour of these salts is probably due to the formation of complex ions even in dilute solutions. Although such disagreement with Kohlrausch's law is found, it might be expected that the curves, extrapolated to infinite dilutions, would have tangents coinciding with those calculated in accordance with Onsager's theory. Actually, however, this is not the case. T. H. P.

1676. Behaviour of Electrolytes in Mixed Solvents. Part I. Free Energies and Heat Contents of Hydrogen Chloride in Water-Alcohol Solutions. J. A. V. Butler and C. M. Robertson. *Roy. Soc., Proc.* 125. *pp.* 694–712, *Nov.* 1, 1929.

The e.m.f. of the hydrogen-silver chloride cell has been determined at 15°, 25° and 35° C. in a series of solutions of hydrogen chloride in water-alcohol mixtures. From the measurements the variation of the free energies and heat contents of hydrogen chloride with (1) the composition of the solvent, (2) the concentration of the electrolyte, are calculated. The free energies indicate that in solutions containing only a small proportion of water, the latter is largely associated with the electrolyte. The heat effects have maximum values in the region 90–95 % alcohol. The most probable explanation of this behaviour is that hydrogen chloride is not completely dissociated in alcoholic solution and the addition of water increases the degree of dissociation. AUTHORS.

1677. Photo-Ionisation in Liquids and Crystals and Dependence of Frequency of X-Ray Absorption Edges on Chemical Constitution. L. Pauling. *Phys. Rev.* 34. *pp.* 954–963, *Sept.* 15, 1929.

Theoretical. The electron affinity of a liquid or crystal is $E \cong \alpha W_0$, where W_0 is the average potential energy of a free electron in the liquid or crystal, and $W_0 = -6{\cdot}43 \times 10^6 K$, where K is the specific diamagnetic susceptibility. For water $E = 3{\cdot}81$ volt-electrons, giving $\alpha = 0{\cdot}82$. For five alkali halides $\alpha = 0{\cdot}80$, whence are deduced value of the diamagnetic susceptibility for the silver halides compatible with photo-ionisation by visible light. The equation $h\nu_{\text{abs}} = h\nu_0 + e^{\Phi(1)} - E_{\text{crystal}}$ (where ν_{abs} is the X-ray absorption edge of an ion in a crystal, ν_0 that for a free ion, $e^{\Phi(1)}$ the electrostatic potential at the centre of the ion due to surrounding ions, and $E_{\text{crystal}} = 0{\cdot}80 W_0$) gives shifts agreeing with those observed for the chlorides of lithium, sodium and rubidium, and the fluoride, chloride, bromide and iodide of potassium. C. A. S.

1678. Conductance Measurements of Binary Salts in Dichlorethylene and Tetrachlorethane. P. Walden and H. Gloy. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 395–440, *Nov.*, 1929.

In continuation of the experiments with ethylene chloride [see Abstract 1699 (1929)] the authors investigate solvents of low-dielectric constant ϵ, dichlorethylene CHCl : CHCl (which is known in two isomers differing strongly as to ϵ, the cis-compound $\epsilon = 9{\cdot}22$ and the trans $\epsilon = 2{\cdot}25$) selecting a mixture of $\epsilon = 6{\cdot}7$, and tetrachlorethane $C_2H_2Cl_4$, $\epsilon = 8{\cdot}2$. The salts are chiefly tetraisoamylammonium picrate, iodide, rhodanide, etc., and other ammonium salts. The dialkyl and trialkyl salts proved poor conductors and weak salts, the tetraalkyl salts good conductors; the latter were studied also at very high dilution ($v = 1{,}000{,}000$ litres). The rule $\epsilon\sqrt[3]{v} = \text{const.}$ for the limiting dilution of the square-root law, the constancy of the product $\lambda_\infty \eta$, and other relations pointed out are again confirmed for these solvents. From the degree of dissociation $\alpha = \lambda_v/\lambda_\infty$, determined for different salts, Ostwald's constant K is calculated, and the law of mass action is found to hold over a large range. The various forms proposed for the relation $\lambda_\infty - \lambda_v = A\sqrt{c}$ are tested; Onsager's modification, based upon the Debye–Hückel dissociation theory, gives values which differ more from the observed values as the ϵ become smaller. H. B.

1679. Absolute Measurements of Surface Conductivity near the Boundary of Optically Polished Glass and Solutions of Potassium Chloride. J. W. McBain, C. R. Peaker and A. M. King. *Am. Chem. Soc., J.* 51. *pp.* 3294–3312, *Nov.*, 1929.

Absolute measurements of specific surface conductivity have been made for the first time. For aqueous $0{\cdot}001N$.KCl at 25° the extra conductivity in the neighbourhood of optically-polished glass, fused silica and optically-polished quartz amounts to a specific surface conductivity of $4{\cdot}3 \times 10^{-8}$ mhos. Thus, in capillary spaces of less than 0·01 mm., half the conductivity may be surface conductivity, ascribable to free mobile ions corresponding to sessile ions of opposite charge upon the solid interface, which are probably not all of negative sign. These mobile ions are not sufficiently numerous to form more than about one-eighth of a monomolecular layer. This is of the same order as that found in the measurements of specific surface of an insoluble fatty acid on conductivity water. H. H. Ho.

1680. Exponent of Hydrogen in Water. A. Kling and A. Lassieur. *Comptes Rendus*, 189. *pp.* 637–639, *Oct.* 21, 1929.

This investigation repeats, extends and confirms previous work in this field [see Abstract 884 (1926)] from which it is concluded that the *p*H value of water is 5·8, and that in consequence pure water is not a neutral solvent. H. H. Ho.

1681. Mobility of Hydrogen and Hydroxyl Ions in Aqueous Solution. H. Zahn. *Zeits. f. Physik*, 58. 7–8. *pp.* 470–477, 1929.

If the view is accepted that in acid solutions hydroxonium, H_3O, ions exist which constantly interchange protons with water molecules then the transport of positive electricity is shared between two kinds of carriers. According to the calculations of Hückel the amount due to the protons must decrease in alternating fields of very high frequency. An account is given in this paper of an investigation according to which with vibrations which correspond to a wave-length of 4 cm. a decrease of the conductivity cannot be observed. J. J. S.

1682. Transport Numbers and Ionic Mobilities in Solutions of Mixed Electrolytes and their Significance in Relation to the Theories of Debye, Hückel and Onsager. K. Bennewitz, C. Wagner and K. Küchler. *Phys. Zeits.* 30. *pp.* 623–634, *Oct.* 1, 1929.

The formulæ derived by Onsager [see Abstract 2642 (1927)] from the Debye and Hückel theory for the ionic mobility of strong electrolytes is here applied to mixed solutions of two electrolytes in which one component is present in vanishingly small concentration. To test the theory, determinations have been made of the ionic mobilities in solutions of barium and potassium chlorides, barium and hydrogen chlorides, and potassium and hydrogen chlorides with total concentration being 0·1 *N*, by measuring the conductivity and the transport number. It is found that the mobility of the hydrogen ion in the mixtures is considerably less than in pure hydrochloric acid of the same chlorine ion concentration. Inversely, the mobility of barium or potassium in the mixtures is somewhat greater than in the corresponding pure salt solutions. The experimental data are in qualitative agreement with the theory. For experimental purposes, however, the measurements were made on solutions with concentrations too high for the quantitative application of Onsager's theory and with a finite ratio between the components. The experimental results are, however, at variance with the classical theory. The conductivity of mixed electrolyte solutions is discussed, an indication being given for the non-additivity of the conductivity in mixtures of potassium and hydrogen chlorides. T. H. P.

1683. Transport Number of Aqueous Acetic Acid. J. W. McBain and C. E. Harvey. *Am. Electrochem. Soc., Trans.* 55. *pp.* 215–221; *Disc.*, 221–225, 1929.

The migration number of a weak electrolyte has been ascertained and compared with the conflicting predictions from the data for corresponding strong electrolytes. The transport number of acetic acid over the whole range of concentrations and temperatures studied is 0·108. It is shown that the anions of acetic acid itself are simple, and it is suggested that the anomalies in the data deduced for the strong electrolytes may be traceable to the presence of complex ions, even when they are in fairly dilute solutions. AUTHORS.

1684. Determination of Dissociation Constants by Quantitative Fluorescence Measurements. J. Eisenbrand. *Zeits. f. phys. Chem.* 144. *Abt. A.* 5–6. *pp.* 441–462, *Nov.*, 1929.

Apparatus is described for investigating the connection between fluorescence and light absorption. It is established in the case of quinine sulphate dissolved in sulphuric acid that there is a logarithmic relationship between the two. In the limiting case this passes over into the previously observed direct proportionality between concentration and fluorescence intensity. The apparatus is employed to determine the constants of dissociation for quinine, metoxyquinoline, and β-naphthol. The observed constants are in agreement with those measured in other ways, or calculated theoretically. Contrary to present views, it is found that there is frequently a connection between the degree of ionisation in a solution and the intensity of fluorescence. A. C. M.

1685. Electrolytic Deposition of Molybdenum. J. L. Merrill and A. S. Russell. *Chem. Soc., J. pp.* 2389–2393, *Oct.*, 1929.

The results of an investigation of the conditions for the electrolytic deposition of Mo are given which show that the most suitable kathode is mercury, the best current densities are 0·6–1·0 amps./cm.^{2} and the best acidities 1·2–1·4 *N* sulphuric acid. The time necessary for the deposition of 0·1 g. Mo was found to be about 50 min., which was not shortened by the use of a rotating anode. Variation in temperature had little effect. Acidity was found to be a more important factor than current density with sulphuric acid solutions, which differs from Férée's results with hydrochloric acid solutions. C. O. B.

1686. Electrolytic Deposition of Tungsten. K. S. Jackson, A. S. Russell and J. L. Merrill. *Chem. Soc., J. pp.* 2394–2398, *Oct.*, 1929.

The results of an investigation of the conditions affecting the electrolytic deposition of tungsten from solutions in hydrofluoric acid, using a mercury kathode, are given. The best conditions were found to be a temperature of 95° C., an acid concentration of approximately 4·6 *N*, and a range of current densities of 0·65–1·0 amp./cm.$_2$ HCl or H_2SO_4 must not be present in the electrolyte. C. O. B.

1687. Effect of Addition Agents upon Conductivity, Kathodic Polarisation and Grain Size of Deposited Copper. B. Clark and E. O. Jones. *Faraday Soc., Trans. pp.* 583–590, *Nov.*, 1929.

The effect of the addition of various substances upon the conductivity, polarisation and grain size of the deposits obtained from the cell $Cu/CuSO_4$, H_2SO_4/Cu, was investigated. The substances added were gelatin, dimethylaniline, grape sugar, lactic acid, starch, peptone, and a saturated solution of camphor. Curves of kathodic polarisation and current density showing the effects of the various materials are given. The grain size was estimated by counting the grains in a given area under a microscope. The bearing of the results on the problem of plating is discussed. F. J. B.

1688. Separation of Columbium and Tantalum by Electrolytic Hydrolysis. L. F. Yntema. *Am. Electrochem. Soc., Trans.* 55. *pp.* 209–211; *Disc.*, 211–213, 1929.

A mixed solution of potassium columbate and tantalate served as the electrolyte in the anode compartment of a cell. A concentration of columbium appeared in the first fractions. The precipitate was granular and easily filtered. The method does not give a complete separation.

AUTHOR.

1689. Electrodeposition of Silver from Argentocyanide Solutions. S. Glasstone and E. B. Sanigar. *Faraday Soc., Trans.* 25. *pp.* 590–598, *Nov.*, 1929.

The effect of addition of various salts to a plating bath on the quality of the silver deposited was investigated. A typical plating solution containing a cyanide was prepared, and to separate portions of it were added definite amounts of carbonate, sulphate, chloride, formate, acetate, cyanide, phosphate, nitrate, borate and hydroxide respectively. The kathode potential of a silver electrode was measured in each solution at various current densities. The deposits were compared for hardness and appearance. The addition of carbonate or of excess of cyanide decreased the hardness of the silver deposit. The limiting current density at which silver could be deposited with 100 % efficiency was a function of the silver concentration of the electrolyte, and not of its conductance. [See Abstract 2871 (1929).] F. J. B.

1690. Electrolysis with Fluorine. W. D. Bancroft and N. C. Jones. *Am. Electrochem. Soc., Trans.* 55. *pp.* 183–195; *Disc.*, 195–198, 1929.

Fluorine gas was made by electrolysing fused potassium hydrogen fluoride in the Mathers cell, using a magnesium metal pot as kathode and a graphite rod as anode. The cell delivers about 250 cc. F^2 gas per Ah and has been in operation for more than a year. The current efficiency is about 30 %. Experiments were then carried out to study the reactions of fluorine with various substances. Fluorine oxidises solutions of cobaltous, chromic, manganous and plumbous salts. Fluorine can undoubtedly be used profitably in many cases of poorly conducting solutions, and where one wishes not to have to deal with the kathode reaction products. When fluorine attacks organic compounds it must displace the least negative radical, or combine with the most positive radical. A new though undeveloped technique for studying organic compounds is thus opened up. When fluorine is brought in contact with benzene vapour there is an induction period, after which the reaction proceeds explosively. AUTHORS.

1691. Oxidation of Alkali Plumbite to Plumbate by Sine Alternating Current. F. Jirsa. *Zeits. f. Elektrochem.* 35. *pp.* 830–833, *Nov.*, 1929.

Explanation of the complicated dependency of the yields obtained in this oxidation [see Abstract 2647 (1927)] on the various factors influencing them is not possible without assuming so-called kathode passivity. The function of such passivity in a.c. electrolysis has not yet been experimentally proved, so that it remains hypothetical, but the results now described are in favour of its existence. With palladium electrodes the yield curve has the same form and follows the same course as the solubility of lead in alkali hydroxide on a.c. electrolysis. Thus the $Pb^{····}$ ions formed by the anode components give complex anions with hydroxyl ions and thus escape reduction, the yield of plumbate being hence dependent on the conditions determining the velocity of formation of these anions. With dilute alkali hydroxide, only few complex anions arise, the plumbate being hydrolysed. Increase in the concentration of the hydroxide is accompanied by increased possibility of formation of complex ions. $Pb^{\cdot\cdot\cdot\cdot} + 5OH' \rightleftarrows 2H_2O + HPbO_3'$, and the yield becomes greater. When the concentration exceeds N – NaOH, a new process, $Pb^{\cdot\cdot\cdot\cdot} + 6OH' \rightleftarrows 3H_2O + PbO_2''$, sets in and the yield falls. A third bend in the curve is explainable by the process, $Pb^{\cdot\cdot\cdot\cdot} + 8OH' \rightleftarrows PbO_4'''' + 4H_2O$. If the palladium electrodes were not kathodically passive, the yield should be as small as with gold or cadmium, which show vanishingly small passivity. The results obtained with nickel electrodes indicate that these are not partially passive, like palladium, but completely passive. T. H. P.

1692. Concentration Changes in Dilute Amalgams of Alkali and Alkaline Earth Metals. F. Skaupy. *Zeits. f. Elektrochem.* 35. *pp.* 862–863, *Nov.*, 1929.

The paper forms a criticism of the paper of le Blanc and Jäckh [see Abstract 427 (1930)]. Alternative explanations of the concentration changes are proposed as a result of other authors' work. F. J. B.

1693. Electrochemical Investigation of Solutions of Antimony Trichloride in Bromine. W. A. Plotnikow and O. K. Kudra. *Zeits. f. phys. Chem.* 145. 3–4. *pp.* 265–275, *Dec.*, 1929.

The specific and molecular conductivity of solutions of antimony trichloride in bromine was investigated. The concentrations of the solutions ranged from 0 to 100 %. The molecular conductivity at first increased with the dilution, reaching a maximum at a dilution of 90 cm. On further dilution the conductivity decreased. Both chlorine and bromine were the products of the electrolysis which separated at the anode. Electrolytic dissociation was considered to take place in accordance with the following equation: $Sb_2Cl_6 \rightleftarrows Sb_2Cl_3^{+++} + 3Cl^-$. F. J. B.

1694. Electrolysis by Means of an Asymmetric Alternating Current. F. Halla. *Zeits. f. Elektrochem.* 35. *pp.* 838–847, *Nov.*, 1929.

From the known properties of the characteristic of direct-current electrolysis, certain of the laws holding for electrolysis by an asymmetric alternating current, or an alternating current superposed on a direct current, are derived. A complete Bibliography is appended. T. H. P.

1695. Behaviour of Adsorbed Electrolytes in D.C. and A.C. Electrolysis. S. L. Bhatia. *Kolloid Zeits.* 50. *pp.* 55–58, *Jan.*, 1930.

The adsorption of copper sulphate and nickel sulphate and their removal from the adsorbent animal charcoal was investigated. Quantities of animal charcoal were treated with copper sulphate or nickel sulphate, and the charcoal thoroughly washed until the washings were metal and acid free. The charcoal containing a proportion of adsorbed salt was submitted to direct or a.c. electrolysis. It was found that direct current separated the adsorbed copper and nickel sulphate from the carbon. Alternating current obtained from an induction coil had no action on the adsorbed salts. At the highest voltage employed, 40 volts, 83·63 % of the adsorbed copper sulphate, and only 50·66 % of the nickel sulphate were removed.
F. J. B.